Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site

Former Plainwell Impoundment Time-Critical Removal Action

Final Construction Completion Report

Kalamazoo River Study Group

March 2010

ARCADIS

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Former Plainwell Impoundment
Time-Critical Removal Action

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Acronyms and Abbreviations

AOC	Administrative Settlement Agreement and Order of Consent
BBL	Blasland, Bouck, and Lee, Inc.
cfs	cubic feet per second
CQA	construction quality assurance
cy	cubic yards
gpm	gallons per minute
HDPE	high-density polyethylene
KRSG	Kalamazoo River Study Group
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
µg/l	micrograms per liter
MS/MSD	matrix spike/matrix spike duplicate
NAD 83	North American Datum 1983
NGVD	National Geodetic Vertical Datum
NTU	nephelometric turbidity unit
OU	operable unit
OSC	On-Scene Coordinator
PCB	polychlorinated biphenyl
QAPP	Quality Assurance Project Plan
RBSL	Risk-Based Screening Level
RRD	Remediation and Redevelopment Division
RTK GPS	real time kinematic global positioning system
SRD	Substantive Requirements Document
TCL	target compound list
TCRA	time-critical removal action
TSCA	Toxic Substances Control Act
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WCS	water control structure

Statement by Supervising Contractor

I am a registered Professional Engineer and represent ARCADIS as the Supervising Contractor for work conducted by the Kalamazoo River Study Group for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site Time-Critical Removal Action. This report is submitted in accordance with Paragraph 20 of the February 2007 Administrative Settlement Agreement and Order on Consent for Removal Action (Docket No. V-W-07-C-863).

Under penalty of law, I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of the report that the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations

Stephen Garbaciak

Stephen Garbaciak Jr., P.E.
Supervising Contractor
ARCADIS

Date: March 2010

1. Introduction

This *Final Construction Completion Report* (Completion Report) has been prepared on behalf of the Kalamazoo River Study Group (KRSG) to summarize the efforts associated with the time-critical removal action (TCRA) conducted in the former Plainwell Impoundment located along the Kalamazoo River near Plainwell, Michigan. The TCRA was completed in accordance with the Administrative Settlement Agreement and Order of Consent for Removal Action, Docket No. V-W-07-C-863 (AOC), dated February 21, 2007 (United States Environmental Protection Agency [USEPA] 2007a). Work activities in support of the TCRA were completed between April 2007 and June 2009.

1.1 General

USEPA determined that the concentrations of polychlorinated biphenyls (PCBs) in the sediments, river bank soils, and floodplain soils of the former Plainwell Impoundment posed an imminent and substantial danger to both human and ecological receptors. As a result, USEPA determined that a TCRA was necessary to address the contamination.

The *Former Plainwell Impoundment Time-Critical Removal Action Design Report* (Design Report) (ARCADIS BBL 2007a) provides a detailed description of the TCRA, including contract drawings and associated specifications followed during implementation of the remedial design in accordance with the AOC (USEPA 2007a). The Design Report was submitted to USEPA in February 2007, approved on February 14, 2007 (USEPA 2007b), and served as the work plan for removal activities.

This Completion Report is designed to satisfy the requirements of Paragraph 20 of the AOC and provide the regulatory agencies with documentation that the actions described in the AOC are complete.

1.2 Project Area Description

The former Plainwell Impoundment is located in Gun Plain and Otsego Townships, downstream of Plainwell, Michigan. It is roughly bounded on the upstream (or southeastern) end by the Main Street Bridge in Plainwell, and on the downstream (or northwestern) end by the Plainwell Dam (Figure 1).

As described in the Design Report (ARCADIS BBL 2007a), when in operation as a hydroelectric facility, the Plainwell Dam had a head of approximately 13 feet, and impounded water covering an area of approximately 123 acres. The Michigan Department of Natural

Resources (MDNR) drew down and partially dismantled the dam – as a result, the remaining sill of the dam had a head of approximately 5 feet and impounded a surface area of approximately 44 acres. The remaining impoundment encompassed approximately 1.9 miles of river, with an average width of 197 feet and an average water depth of 3.7 feet. The channel slope within this reach was approximately 4.6 feet/mile.

As described in Section 1.2 of the Design Report (ARCADIS BBL 2007a), the former Plainwell Impoundment has been the focus of an extensive series of investigations by ARCADIS (formerly known as Blasland, Bouck & Lee, Inc [BBL] and ARCADIS BBL), MDNR, and USEPA since 1993. The most recent PCB data were collected during a sampling effort conducted by ARCADIS in 2006. A variety of targeted studies of the impoundment were also conducted in 2005 and 2006 to further characterize project area topography, bank stability/disposition, flow hydrodynamics, equipment accessibility, and habitat quality.

1.3 Overview of Response Actions and Summary of Work Performed

The activities completed at the former Plainwell Impoundment were consistent with the requirements of the Design Report. In summary, the TCRA was performed to achieve the following objectives set forth in the Design Report (ARCADIS BBL 2007a):

1. Dredging and/or excavation of PCB-contaminated sediments upstream of the Plainwell Dam; in the three discrete sediment areas identified as Mid-Channel Areas A, B, and C; and within 40 feet of the existing (pre-removal action) bank.

    - See Section 3.5.1 for a summary of PCB sampling criteria. See Sections 3.5.2.1 and 3.5.2.2 for a definition of and confirmation monitoring summary for near-shore and mid-channel areas; see Sections 3.5.3 and 3.5.4 for a description of removal activities.

2. Cut-back and stabilization of river banks to mitigate exposures to PCB-contaminated banks, control future bank erosion, and achieve a stable channel.

    - See Section 3.5.2.3 for a definition of bank cutback areas and Sections 3.5.3 and 3.5.4 for a description of removal activities.

3. Removal of PCB-contaminated floodplain soils identified from pre-removal action data to contain PCB concentrations greater than 50 milligrams per kilogram (mg/kg) PCBs.

- See Section 3.5.1 for a summary of PCB sampling criteria. See Section 3.5.2.4 for a definition of floodplain areas and sampling activities and Sections 3.5.3 and 3.5.4 for a description of removal activities.

4. Removal of PCB-contaminated soil in excess of 4 mg/kg PCBs from the river's northern floodplain on or near residential properties upstream of US 131, to the extent that the floodplain can be reasonably accessed.

   - See Section 3.5.1 for a summary of PCB sampling criteria. See Section 3.5.3.1 for a summary of excavation activities in Removal Area 1.

5. Dewatering, as necessary, and disposal of all removed PCB-contaminated sediment and bank and floodplain soils in commercial landfills located offsite.

   - See Section 3.6 for summary of dewatering activities and Section 3.7 for a summary of transportation and disposal of sediment and soil.

6. Use of clean soils excavated as part of the bank cutback work to cover floodplain soils contaminated above human health or ecological risk levels (to the extent clean soils could be identified and isolated for use as cover).

   - See Section 3.5.4 for a summary of excavation and sampling of soil to potentially be used as clean cover in floodplain soils.

7. Control of resuspended sediment.

   - See Section 3.3 for a summary of resuspended sediment control and monitoring.

8. Removal of PCB-contaminated sediments abutting the Plainwell Dam.

   - See Section 3.5.3 for a summary of sediments removed near the Plainwell Dam and former powerhouse structure.

9. Construction and operation of a water-level control structure (WCS) in the channel to facilitate the removal of in-stream and bank material.

   - See Sections 3.4.2, 3.5.5, and 3.9.3 for the installation, operation, and removal of the WCS.

10. Removal of one or more portions of the Plainwell Dam structure as needed to reduce the risk of sudden failure of the Plainwell Dam and/or minimize short- and long-term PCB mobilization from banks and floodplains.

    - See Section 3.5.3.17 for a summary of the removal of the former powerhouse structure.

11. Establishment of a stable river channel post-removal and revegetation with native plant species.

    - See Section 3.8 for a summary of bank stabilization and habitat reconstruction.

12. Monitoring during and after the removal action.

    - See Section 3.3.4 for a summary of monitoring activities performed during construction activities and Section 4 for a summary of post-removal controls in the project area.

Construction activities performed to achieve these objectives are described in the sections referenced after each bullet point.

1.4 Shoreline Conditions and Habitat Design Performance Objectives

This Completion Report demonstrates that construction activities achieved the performance objectives defined in Section 1.3 that were achievable upon completion of the construction project. Objectives 2 and 11, which involve bank stabilization and creation of a stable river channel, are long term objectives that were anticipated in the Design Report as not being immediately established at the conclusion of construction activities. Construction activities described in Section 3.8 of this report demonstrate that work was performed as described in Section 2.7 of the Design Report; these activities are summarized below.

Channel Design

The process for restoring the disturbed banks and floodplain described in the Design Report was developed based on an approach that incorporated applicable natural channel design procedures and analytical hydraulic principles. Channel design was informed or constrained by the following:

- Development along the river in the City of Plainwell - including the location of and constriction imposed by the US 131 bridge and the 12th Street Landfill - limited the long-term location of the river channel.

- Preference to minimize the use of hard armor and maximize the habitat benefits of the restored banks.

- Results of Rosgen and other quantitative analyses that indicated that working within a 30-foot buffer/removal zone would allow banks to become sufficiently stable over time to mitigate the potential for the river to meander into the exposed PCB-containing former river sediments that would remain in the former impoundment landward to the buffer.

- Construction activities designed not to make major physical modifications to the slope, width, or sinuosity of the channel.

Neither the natural channel bed substrate nor stable cross sections were immediately re-established as a part of removal activities. Instead, the channel was allowed to restore via a natural channel process.

This methodology promoted the natural evolution of a stable channel in response to both the removal of the powerhouse portion of the Plainwell Dam and the longer term erosion of the mid-channel sediments not targeted for removal. Although the post-removal channel was designed to be initially unstable to facilitate the erosion of the remaining mid-channel sediments, the bed was expected to eventually return to a stable, pre-impoundment elevation corresponding to the gravel and cobble pre-impoundment bed. This methodology was designed to reintroduce the original bed slope, maintain historical sinuosity in the reach, and allow the channel to scour down to the pre-impoundment bed.

Bank Design

Bank excavation was designed with the knowledge that without bank protection, until vegetation is reestablished, the post-construction banks would be more susceptible to erosion and horizontal migration of the channel and associated bank failure. The banks were designed to be stable in the long term, and some erosion was anticipated immediately after construction was completed. Erosion of banks is not necessarily a sign either of an unstable channel or even of an unstable bank, as most natural streams are dynamic systems and have areas of actively eroding and depositing banks. The amount and type of erosion protection required or appropriate to stabilize a bank varied with the location within the river system. Bank restoration methodologies were selected for areas targeted for removal based on geomorphic tendencies and location within the channel planform, modeled water velocities, bank slope, and top of bank land use.

Bank stabilization, accomplished primarily through vegetation establishment and limited hard armoring, was designed to provide long-term support for the existing planform of the river, and limit the potential for river meander or widening in the project area. The ultimate goal of the restoration design was to provide bank protection and habitat improvements including appropriate riparian hydrology when the river water levels reach equilibrium; this final point of equilibrium was expected to be an elevation similar to pre-impoundment conditions and was not intended to be the condition immediately post-construction.

Summary

A full description of the stable bank and channel design can be found in Section 2.7 of the Design Report. Based on work at other sites, the geomorphic response following the dam removal should occur within a 1- to 5-year time period. Monitoring and maintenance activities will be conducted as described in Section 5.6 of the Design Report to evaluate the stability of restored banks and the development of upland and wetland habitats to meet vegetation performance standards. An adaptive management plan will be utilized if necessary to modify the restored banks. See Section 4 of this report for additional information.

1.5 Scope of the Completion Report

This Completion Report describes the completed response actions at the former Plainwell Impoundment and contains the following information:

- Material testing and certification results
- Sediment and soil removal narrative
- Waste disposal manifests
- Confirmation sample results
- Habitat and bank restoration records
- Final sediment excavation elevations, documented on as-built plans with elevations referenced to the appropriate vertical datum

- Daily activity logs, which include equipment calibration records, air monitoring records, construction dewatering, sediment/soil drainage, water treatment records, and daily weather conditions

- Turbidity monitoring records

- Summary of any problems and/or deficiencies encountered during construction

- A good faith estimate of total project cost

- Certification by the Supervising Contractor that based on the Supervising Contractor's knowledge and review of the construction records, the construction met the requirements of the engineering plans

The scope of this Completion Report is limited to the activities necessary to complete the TCRA.

1.6 Report Organization

The remainder of this Completion Report is organized into five sections. A brief overview of each of the subsequent sections is presented below.

- Section 2 – Project Overview; describes the project organization, provides a summary of the work performed, and describes deviations from the Design Report.

- Section 3 – Removal Activities; presents a summary of activities for each element of the project.

- Section 4 – Post-Removal Controls; describes post-construction activities focusing on several aspects of the work, including monitoring of the banks and revegetation efforts.

- Section 5 – Summary; summarizes how the removal activities achieved the objectives set forth in the Design Report.

- Section 6 – References; lists documents used in preparation of this Completion Report.

Tables, figures, and appendices are also included to provide further detail, as appropriate.

2. Project Overview

This section describes the project organization, provides a summary of the work performed and the performance standards for the TCRA, and describes deviations from the Design Report (ARCADIS BBL 2007a).

2.1 Project Organization

Several organizations were responsible for completion of the TCRA in the former Plainwell Impoundment. These organizations and their associated roles and responsibilities are described below.

The KRSG is composed of current or former owners of paper recycling facilities that existed along the Kalamazoo River near Kalamazoo. The KRSG entered into the AOC and was responsible for performing the TCRA in the former Plainwell Impoundment.

USEPA, MDNR, and Michigan Department of Environmental Quality (MDEQ) (known collectively as the regulatory agencies) signed the AOC with the KRSG and provided oversight and documentation of construction activities. Design changes and construction issues were discussed with the regulatory agencies, as necessary. The regulatory agencies consulted with other government agencies as necessary, including, but not limited to United States Fish and Wildlife Services and National Oceanic and Atmospheric Administration.

ARCADIS served as the Supervising Contractor for the project. In this role, ARCADIS implemented the TCRA on behalf of the KRSG and provided full-time construction management and construction quality assurance (CQA) services for the duration of removal activities. ARCADIS documented that the TCRA was implemented in conformance with the approved work plan (the Design Report), documented progress towards meeting design objectives, recorded daily work activities, performed construction monitoring, directed subcontractors, provided health and safety oversight, and approved field changes.

ARCADIS appointed a CQA Observer who was responsible for daily construction oversight to verify that the construction was performed in general conformance with the Design Report (ARCADIS BBL 2007a). CQA also included observation, testing, and documentation of certain construction phases on a periodic basis to verify conformance with the approved guidance and design documents. The CQA Observer reviewed pre-removal submittals and conformance test results and prepared Daily Construction Reports with photographs to communicate the project's progress to the project team throughout the course of construction.

The CQA Observer identified and documented construction problems or deficiencies and discussed them with the Supervising Contractor (who had ultimate technical responsibility for the work performed) and related parties as required to implement corrective action. A team of environmental and geotechnical engineers and other experts, as appropriate, provided engineering and construction support and management. Corrective actions to resolve problems or deficiencies were implemented by subcontractors and observed and documented by the CQA Observer.

ARCADIS retained various subcontractors to perform construction activities associated with the TCRA. Terra Contracting, LLC of Kalamazoo, Michigan was selected as the primary removal contractor and was responsible for support facilities and access road construction, soil and sediment excavation activities, installation of resuspended sediment controls, construction dewatering and water treatment, management of waste transport and disposal, and restoration of excavated areas. The King Company, Inc. of Holland, Michigan was responsible for installation and removal of the WCS and two cofferdams; Schrader Environmental Services of Ithaca, Michigan treated water pumped from the Phase 1 Cofferdam Area; American Environmental Group of Richfield, Ohio installed geotextile fabric and liner at the staging areas; and JF New of Walkerton, Indiana revegetated the excavated and restored areas. Subcontractors retained other firms, as necessary, to complete their scope of work.

2.2 Summary of Work Performed

The following activities (described further in Sections 3.2 through 3.10) were completed to achieve the objectives of the TCRA, as described in Section 1.3:

- Completion of pre-construction activities
- Installation of resuspended sediment control structures
- Installation of Phase 1, Phase 2 Cofferdams, and the WCS
- Removal of near-shore, mid-channel, bank and floodplain soil and sediment
- Dewatering, processing, and treatment, as necessary, of excavated materials
- Transportation and disposal of sediments and soils
- Bank stabilization and habitat reconstruction
- Removal of Phase 1, Phase 2 Cofferdams, and the WCS
- Project area restoration and demobilization

The TCRA was completed between May 2007 and June 2009. Phase 1 construction activities (referred to as the 2007 construction season) were completed between May 2007 and January 2008. Phase 2 construction activities (referred to as 2008 construction season) were completed between March 2008 and June 2009. Removal activities were suspended for the winter in February 2008. Water treatment and project area preparation activities continued during this time.

2.3 Deviations from the Design Report

Work activities that deviated from the Design Report were performed due to unexpected conditions encountered in the field or at the request of the regulatory agencies. All changes were discussed by the Supervising Contractor and the regulatory agencies prior to implementation, and were documented by the CQA Observer and through correspondence with the regulatory agencies. The text of the Design Report was not modified. Specific deviations from the Design Report are discussed below.

2.3.1 Waste Disposal

According to Section 2.10 of the Design Report (ARCADIS BBL 2007a), excavated soil and sediment were to be transported to the Allied Operable Unit (Allied OU) in Kalamazoo, Michigan for disposal. After discussions with the regulatory agencies in April 2007, it was established that excavated soil and sediment would not be disposed of at the Allied OU. On April 24, 2007, the KRSG submitted a letter to USEPA titled *Plainwell Time Critical Removal Action (*KRSG 2007). The letter proposed that:

1) No materials generated during the TCRA in 2007 would be transported to and disposed at the Allied OU.

2) Sediments would be segregated into Toxic Substances Control Act (TSCA) and non-TSCA waste streams using the methodology approved by USEPA for the Lower Fox River Site in Wisconsin, as described in the *2007 Pre-Final Design Report and Remedial Action Work Plan (*Fox River Work Plan; ARCADIS BBL 2007b*)*.

3) Soil would be segregated into TSCA and non-TSCA waste streams using the USEPA-approved methodology for upland, non-sediment wastes.

4) TSCA and non-TSCA waste streams would be disposed at licensed, offsite disposal facilities. The disposal facilities were not selected, and a decision about the destination for materials excavated during 2008 was not made at that time.

USEPA approved the waste disposal proposal on April 25, 2007 in a letter titled *Modification to the Work for the Former Plainwell Impoundment Time-Critical Removal Action* (USEPA 2007c*).*

2.3.1.1 TSCA Segregation

As outlined above, sediment was segregated into TSCA and non-TSCA waste streams following the USEPA-approved protocol used at the Lower Fox River Site in Wisconsin, as described in the Fox River Work Plan (ARCADIS BBL 2007b). Soil was segregated into TSCA and non-TSCA waste streams using the USEPA-approved methodology for upland, non-sediment wastes. The waste stream classifications were determined using a depth-weighted average of pre-removal PCB concentrations. ARCADIS electronically transmitted polygons showing TSCA and non-TSCA areas to USEPA and MDEQ on May 4, 2007 (ARCADIS BBL 2007c). Additional information regarding the methodology used to define TSCA and non-TSCA areas can be found in the Fox River Work Plan (ARCADIS BBL 2007b) and in the May 4, 2007 submittal.

Waste material with a depth-weighted average PCB concentration greater than or equal to 50 mg/kg was disposed as TSCA waste. Waste material with a depth-weighted average PCB concentration less than 50 mg/kg was disposed as non-TSCA waste. USEPA approved the TSCA and non-TSCA delineation on May 8, 2007 in a letter titled *Modification to Work Plan for the Plainwell Impoundment Time-Critical Removal Action, Docket No. V-W-07-C-863.* (USEPA 2007d*).*

2.3.1.2 Landfill Selection

On June 4, 2007, the KRSG verbally notified USEPA that non-TSCA wastes would be disposed at the C&C Landfill, located in Marshall, Michigan and operated by Allied Waste Industries, Inc. (Allied Waste); and TSCA wastes would be disposed at Wayne Disposal, Inc., located in Belleville, Michigan and operated by The Environmental Quality Company. Both landfills were in compliance with applicable USEPA and MDEQ regulations.

On November 20, 2007, ARCADIS submitted a letter to USEPA titled *Notification of Additional Landfill Usage Former Plainwell Impoundment Time-Critical Removal Action Kalamazoo River Study Group* (ARCADIS BBL 2007d). The letter informed USEPA that for the remainder of the 2007 construction season, non-TSCA wastes would also be sent to the Ottawa Farms Landfill, located in Coopersville, Michigan and operated by Allied Waste.

Between the 2007 and 2008 construction seasons, the regulatory agencies and the KRSG agreed that waste material disposed in 2008 would continue to be disposed at the landfills used for disposal in 2007. No material would be disposed at the Allied OU.

2.3.2 Excavation Performed at the Request of USEPA

During the course of the project, USEPA directed KRSG to complete additional excavation activities that were outside the scope of the Design Report.

2.3.2.1 Removal Area 1

On July 11, 2007, USEPA issued a letter to the KRSG titled *Modification to Former Plainwell Impoundment Area Time-Critical Removal Action Design Report to Require the Removal of Additional Near-Shore Sediment in Removal Area 1* (USEPA 2007e), describing an additional sediment deposit in Removal Area 1 located between river markers 70+50 and 72+25. This area had been inspected by USEPA and determined to contain a soft sediment deposit that could potentially contain PCBs outside of the previously defined boundaries of Removal Area 1. See Section 3.5.3.1 for a description of removal activities in Removal Area 1.

2.3.2.2 Removal Area 2B

On July 10, 2007, USEPA issued a letter to the KRSG titled *Removal Area 2B (additional removal on City of Plainwell property)* (USEPA 2007f) that described the need to remove approximately 450 linear feet of material located upstream of and adjacent to Removal Area 3B. According to the letter, exposed residuals had been observed in this area. The letter described excavation of floodplain soils in the area between river marker 65+50 and 69+00, referred to as Removal Area 2B. See Section 3.5.3.3 for a description of removal activities in Removal Area 2B.

2.3.2.3 Removal Area 11B

On May 12, 2008, USEPA issued a letter to the KRSG titled *Modification to Former Plainwell Impoundment Area Time-Critical Removal Action Design Report to Require Changes to the Bank Soil PCB Concentration Confirmation Monitoring and Inclusion of Area 11B in the Removal Action* (USEPA 2008a) that described the need to remove approximately 300 linear feet of material located between Removal Area 10B and Removal Area 12B. The area was referred to as Removal Area 11B and had not been included in the scope of the Design Report (ARCADIS BBL 2007a) because it was thought to be inaccessible; however, based upon visual observations, USEPA determined that removal activities in this area were feasible. The letter also described a modification to the bank soil confirmation monitoring area, which is discussed in Section 2.3.3. See Section 3.5.4.6 for a description of removal activities in Removal Area 11B.

2.3.2.4 Removal Area 6B

Excavation and confirmation monitoring activities were completed in Removal Area 6B in October 2007; however, the area was not fully revegetated at that time. In May 2008, USEPA observed visible gray material in the 30-foot clean buffer floodplain soil area of Removal Area 6B. A test pit was excavated in the area to determine the extent of the material in question. On June 4 and 5, 2008, USEPA collected soil samples from five of the eight soil confirmation sampling grids located in the floodplain of Removal Area 6B.

On July 23, 2008, USEPA issued a letter titled *Removal Area 6B – Additional Excavation Needed in Grids 4, 5, and 6* (USEPA 2008b), which directed the KRSG to excavate an additional 2 to 12 inches of material from Grids 4, 5, and 6. See Section 3.5.3.12 for a description of removal activities in Removal Area 6B.

2.3.3 Bank Soil Confirmation Monitoring

On May 12, 2008, USEPA issued a letter to the KRSG titled *Modification to Former Plainwell Impoundment Area Time-Critical Removal Action Design Report to Require Changes to the Bank Soil PCB Concentration Confirmation Monitoring and Inclusion of Area 11B in the Removal Action* (USEPA 2008a) that described a modification to the definition of the bank soil confirmation monitoring area. The letter also described the inclusion of Removal Area 11B to the TCRA, which is discussed in Section 2.3.2.3.

According to the Design Report (ARCADIS BBL 2007a), the bank soil confirmation monitoring area originally consisted of the area between the top-of-bank (land side) and the dam-in median water line (water side). If the dam-in median water line was landward of the top-of-bank, no bank samples were collected.

The near-shore confirmation monitoring area was defined as outward from the dam-in median water line. USEPA, in consultation with MDEQ, expressed concern that excavation of the area between the dam-in median water line and the toe-of-slope was not being thoroughly characterized post-construction and could contain PCB concentrations above the cleanup criterion. The bank soil confirmation monitoring area was redefined to include those areas situated between the top-of-bank and the toe-of-slope, where the new river bank intersects with the in-stream sediment removal area.

2.3.4 Underground Utility Lines

Two underground natural gas pipelines were identified near the downstream end of Removal Area 10 and the upstream end of Removal Area 11. ARCADIS attempted to identify the depth and location of the pipelines so that sediment could be excavated from the area without causing damage to the pipelines or compromising worker safety. However, after contacting the natural gas utility representatives and considering other actions to locate the underground pipelines, the utility lines could not be accurately located. The lateral location of the utility lines could be approximated based on signage and construction records possessed by the utility companies. However, no information regarding the depth of the pipelines was available.

On August 12, 2008, ARCADIS submitted a technical memorandum to USEPA titled *Technical Memorandum – Underground Utility Lines at the Allied Paper Inc./Portage Creek/Kalamazoo River Superfund Site Time-Critical Removal Action* (ARCADIS 2008c). This document summarized the actions taken to locate the underground utility lines and alternative approaches considered to safely excavate nearby sediment. Because the depth and location of the underground utility lines could not be adequately determined, the owners of the pipelines recommended that an area of 30 feet on either side of the utility lines be excluded from excavation activities.

Based upon review of the technical memorandum, USEPA directed that a 30-foot exclusion zone be placed on either side of the underground utility lines. On October 8, 2008, USEPA submitted to the KRSG a letter titled *Modification to Former Plainwell Impoundment Time-Critical Removal Action Design Report to Address Underground Utility Lines* (USEPA 2008c) that summarized the agreement regarding the utility line crossing. The USEPA letter directed that all visible soil and sediments (those above the water line) be excavated. The 30-foot exclusion zone only applied to underwater sediments in Removal Areas 10 and 11 and Mid-Channel Area C. In addition, as the water level in the Kalamazoo River decreased due to seasonal variations in water level or due to the removal of the WCS and additional sediments became visible, the KRSG was to excavate the newly visible sediments.

2.3.5 Habitat Reconstruction Plant Species

Through discussions with the habitat reconstruction subcontractor, ARCADIS determined that some tree and shrub species scheduled to be planted in spring 2008 as a part of habitat reconstruction activities would not be available for planting until fall 2008. The planting plan was revised to reflect available tree and shrub species. On March 31, 2008, ARCADIS, MDEQ, and MDNR had a conference call to discuss the revised planting plan, and as a result, the following actions were implemented:

- Redbud was planted in fall 2008 instead of spring 2008.

- The available stock of containerized pagoda dogwood was planted in spring 2008 to the extent feasible. Bare root pagoda dogwood plants were used in the areas where dogwood was originally called for once the stock of containerized dogwood was exhausted. Three bare root dogwoods were planted in the spring of 2008 for every one containerized species outlined in the Design Report.

- Two willow species (pussy and narrowleaf) were not available in containerized stock for spring 2008 planting. Three bare root willows were planted for every one containerized species outlined in the Design Report.

- The performance standard for survivability of the bare root stock was lowered to 66% to account for the lower expected survivability of bare root stock compared to containerized stock.

On April 7, 2008, ARCADIS submitted a memorandum to USEPA titled *Restoration Plantings in Plainwell, MI* (ARCADIS 2008d) that summarized the conclusions of the conference call. USEPA approved the modifications to plant species via email on April 11, 2008 (USEPA 2008d). See Section 3.8 for additional information regarding habitat reconstruction.

2.3.6 Post-Construction Surface Sediment Sampling Depth

At the end of each construction season, sediment samples were collected from the sediment removal areas that were excavated during that construction season. According to Section 5.6.1 of the Design Report (ARCADIS BBL 2007a), surficial sediment samples (0- to 2-inch depth) were to be collected using a petite Ponar® dredge or similar equipment at three locations approximately equally spaced within each removal area. Sample locations were to be approved by the regulatory agencies prior to collection.

Post-construction sediment samples were collected at the end of the 2007 construction season in accordance with the method described in the Design Report. However, at the request of the regulatory agencies, the method was modified for the samples collected at the end of the 2008 construction season. ARCADIS proposed to collect samples using 3-inch Lexan® core tubes and record the observed stratigraphy of sediments at the sample locations. The Lexan® core tubes were driven by hand and pushed to a depth of approximately 2 feet, or to refusal, if soft sediments were present in recoverable quantities. If no soft sediments were present, or if sediments could not be collected with a core tube (i.e., due to gravel or other sediments that would not stay in a core tube) then a surficial grab sample was obtained using a Ponar®

dredge or hand auger. USEPA approved the modification to the post-construction sampling plan in a January 29, 2009 letter titled *Plainwell Post-Construction Surface Sediment Sample Locations 2008* (USEPA 2009). See Section 4.5 for additional information regarding post-construction surface sediment sampling.

2.3.7 Groundwater Monitoring

As described in Section 5.7 of the Design Report (ARCADIS BBL 2007a), a network of 15 monitoring wells and three staff gauges were to be installed throughout the TCRA project area after completion of construction activities to evaluate the presence of PCBs in groundwater, assess the migration of PCBs (if any) to the river, and develop groundwater data to support an ecological risk assessment, if appropriate. The wells were to be sampled quarterly for a period of 2 years at the conclusion of TCRA work activities.

The groundwater monitoring plan as described in the Design Report (ARCADIS BBL 2007a) was modified prior to implementation based on discussions with USEPA and MDEQ. Specifically, changes to well locations, well construction, and well development were made. In addition, two staff gauges were added to the network, water level data were collected and monitored for a period of 2 weeks prior to each sampling event, and two surface water samples were collected from the Kalamazoo River during each sampling event. These changes were approved by USEPA and MDEQ during a March 2, 2009 conference call with ARCADIS and were summarized in the March 4, 2009 letter titled *Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site Time Critical Removal Action – Former Plainwell Impoundment Groundwater Monitoring Well Installation Plan* (ARCADIS 2009a).

3. Removal Activities

3.1 General

This section describes the actions performed to complete removal activities at the former Plainwell Impoundment. Removal activities were implemented between May 2007 and June 2009, and included pre-construction activities; installation of resuspended sediment control structures; installation of the Phase 1 and Phase 2 Cofferdams, and the WCS; soil/sediment removal; material dewatering, processing, and water treatment; transportation and disposal of sediments; bank stabilization and habitat reconstruction; removal of the Phase 1 and Phase 2 Cofferdams, and the WCS; and project area restoration and demobilization. Daily activity reports are included in Appendix A and a photographic log is included in Appendix B.

3.2 Pre-Construction Activities

Pre-construction activities, such as permitting; obtaining property access; identifying aggregate sources; mobilization and project area preparation; access road and staging area construction; and installation of erosion controls were performed by ARCADIS and its subcontractors in preparation for the TCRA at the former Plainwell Impoundment. These activities are described in the following sections.

3.2.1 Permitting

Consistent with the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act Section 121(e) (1), no permits for removal activities were required because all removal activities were conducted onsite.

ARCADIS received a permit from MDNR to install buoys in the river (MDNR 2007) to mark construction areas. MDNR closed the river to recreational use during construction activities. See Section 3.2.4 for additional information. The water generated during soil and sediment dewatering was managed in accordance with Substantive Requirements Document (SRD) – No. MIU990025 (MDEQ 2007). See Section 3.6.2 for additional information.

3.2.2 Property Access

ARCADIS obtained property access from private property owners to conduct construction activities on their properties. Access to property owned by MDNR was provided in the AOC.

3.2.3 Identification of Borrow Material

Sources of sand, backfill, aggregate material, river run rock, and concrete (collectively, borrow material) were identified prior to construction. Borrow material sources were contacted to verify that material was available in the required quantities.

Borrow material used in restoration or grading activities was sampled at a rate of one composite sample per 10,000 cubic yards (cy) prior to use. Composite samples consisted of nine subsamples collected from various areas of the offsite source material selected in the field and biased towards areas of staining, if present. Backfill samples were analyzed for Target Compound List (TCL) volatile organic compounds, TCL semivolatile organic compounds, TCL pesticide/PCBs, Resource Conservation & Recovery Act metals, and total petroleum hydrocarbons (diesel range organics and gasoline range organics). Topsoil sources were also analyzed for grain size, pH, and total organic content to verify that they would support vegetation. Results of the sampling are summarized in Table 1 and laboratory analytical data are included in Appendix C-1. Samples were collected in accordance with the project-specific Quality Assurance Project Plan (QAPP) (ARCADIS BBL 2007e).

Analytical results were compared to applicable Part 201 cleanup criteria and Part 213 risk-based screening levels provided in Operational Memorandum No. 1 (Table 2, Column #19, *Direct Contact Criteria & RMSLs*), issued by the Remediation and Redevelopment Division (RRD) of MDEQ on December 10, 2004. Sampling results indicate that all material from the borrow sources were acceptable for use.

Soils that were over-excavated from floodplain areas to potentially be used as clean cover were subjected to the sampling criteria established for offsite borrow sources. These over-excavated floodplain areas are discussed in Section 3.5.4.

3.2.4 Mobilization and Project Area Preparation

Clearing and grubbing of vegetation from wooded areas was performed to the extent required throughout the project to establish access roads, staging areas, project support areas, and excavation areas. Cleared vegetation was chipped and used for dust and erosion control, hauled to landfills for offsite disposal, or staged for later use.

Project area preparation activities commenced in April 2007 and included mobilization and construction of equipment, materials, support facilities, and personnel necessary for completion of the project. Support facilities included two temporary trailers for the subcontractor, one temporary office trailer for the regulatory agencies, and one temporary office for ARCADIS.

Facilities also included worker sanitation areas, equipment maintenance and storage areas, break areas, and personal decontamination areas.

Security measures including chain link fence and locked access gates were installed at each active work area within the project area. Temporary high-visibility fencing was used in areas where work did not warrant permanent fencing or to distinguish areas such as exclusion zones. Notification and warning signs were also posted where appropriate to label work areas.

With the cooperation of MDNR, the river was closed to public access throughout the duration of the project. MDNR provided signage stating that the river was closed. These signs and standard regulatory buoys were deployed by ARCADIS both upstream and downstream of the project area. Public notices were issued through MNDR and ARCADIS public communications specialists.

The *Traffic Control Plan Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site* (Traffic Control Plan, ARCADIS BBL 2007f) was issued in April 2007 to detail traffic route entrances to public roads, traffic control measures, safety procedures, communication, and manifesting procedures. An addendum to the Traffic Control Plan to address alternate truck routes to the landfills due to construction and road closures was issued in June 2008 (ARCADIS 2008e).

An initial assessment of existing road conditions was performed and documented on April 19, 2007. Truck routes and road conditions were reassessed and documented in April 2008 for the 2008 construction season. Roads, entrances, and exits were cleaned and repaired as necessary throughout the duration of the project.

3.2.4.1 Access Road Construction

Access roads were constructed to provide access to work areas along the banks of the Kalamazoo River and material staging areas, and to connect staging areas to public roadways (Figure 2). The roads were constructed of geotextile material underlying aggregate material imported from the offsite borrow source. The aggregate was sampled according to the parameters described in Section 3.2.3. Nine access points located on MDNR, City of Plainwell, and both private commercial and residential property were established to access work areas.

Access roads connecting the work areas to the staging areas were referred to as haul roads. Prior to leaving the project area, vehicles that used the haul roads were decontaminated by a truck tire wash installed at each staging area. Water from the truck tire wash was collected and treated with the decant water. See Section 3.6.2 for additional information regarding water treatment.

Where appropriate, pre- and post-construction soil samples were collected from access roads constructed on private property. Access roads constructed on concrete, asphalt, or some other kind of paved surface could not be sampled. Pre- and post-construction soil sampling was not required on MDNR property. Air was monitored daily for particulate matter near the access roads. Air monitoring logs are included in the daily activity reports in Appendix A

The pre- and post-construction soil samples were collected to document the PCB concentration of subsurface soil before and after the TCRA. Samples were collected from 0 to 6 inches below the surface using a stainless steel trowel and submitted to KAR Laboratories in Kalamazoo, Michigan or Test America Laboratories (TAL) in Burlington, Vermont for PCB analysis. Access roads were sampled at a rate of one sample every 200 feet. Pre- and post-construction sampling results are included in Table 2. Laboratory analytical data are included in Appendix C-2. Samples were collected in accordance with the project-specific QAPP (ARCADIS BBL 2007e).

3.2.4.2 Staging Area Construction

Five staging areas were constructed for sediment and soil dewatering, processing, and staging before transport for offsite disposal. The staging areas were also used to collect and treat decant water from gravity drainage of the excavated sediments and soils. Staging Areas located on the northern (N) or southern (S) sides of the river were numbered from upstream to downstream. The staging areas, identified as Staging Areas 1N, 2S, 3S, 4N, and 5S, varied in size (Figure 2). Staging area construction included grading and constructing berms from the underlying material to facilitate the collection of decant water for water treatment, installation of geosynthetic liner material, installation of aggregate material, set-up of material processing facilities, and installation of the water treatment system. The size, location, and layout of the staging areas described in the Design Report were modified as necessary based on field conditions. Locations and orientations were modified at the request of the land owner whose property was utilized for staging area construction. Size was modified based on the estimated quantity of material to be processed in the area, and the layout of the staging area was modified to maximize the material processing area. See Figure 3 for the typical as-built layout of the staging areas. Table 3 summarizes the size and operating dates of the five staging areas.

Table 3 -- Staging Area Size and Operating Dates

Staging Area	Approximate Area (square feet)	Date Constructed	Date Removed
1N	36,500	May 2007	September 2007
2S	27,900	July 2007	October 2007
3S	38,300	September 2007	May 2008
4N	66,200	April 2008	January 2009
5S	46,900	August 2007	November 2008

The rectangular staging areas were cleared of vegetation and graded to collected water at one end. A sand base was installed on the staging area and berms were constructed around the sides. Three layers of geosynthetic material were installed on top of underlying sand material. The geosynthetic layers served as a barrier between excavated material and the ground surface, and consisted of 40-millimeter high-density polyethylene (HDPE) geomembrane liner installed between two layers of non-woven geotextile fabric. The geotextile fabric was used to provide support and to prevent damage to the geomembrane liner. The HDPE layer served to prevent rainwater and decant water from dewatering activities from migrating into the subsurface soils. Material specifications for these materials are included in Appendix D. The HDPE was seamed and tested to ensure proper installation. Seaming records can be found in Appendix E. Aggregate material was installed above the second layer of geotextile fabric to serve as a base for work activities.

Depending on the intended use of the area, two types of aggregate material were placed above the geotextile material. 21AA aggregate was installed in areas used by off-road trucks and gravel-train trucks. Both natural and crushed concrete types of aggregate material were used. 6A rounded stone aggregate was used in sediment and soil decanting, processing, and staging areas. The material was sampled prior to use according to the sampling procedures outlined in Section 3.2.3. Results of the sampling are summarized in Table 1 and laboratory analytical data are included in Appendix C-1. A water truck was used in the staging areas for dust control as conditions warranted. Air was monitored daily for particulate matter near the staging areas. Air monitoring logs are included in the daily activity reports in Appendix A.

As described in Section 3.2.4.1 for access road construction, pre- and post-construction samples were collected from the staging areas. A five-part composite sample, composited from the four corners and center of the staging area, was collected from each staging area constructed on private property. Samples were analyzed as described in Section 3.2.4.1.

Pre- and post-construction sampling results are included in Table 2. Laboratory analytical data are included in Appendix C-2.

3.2.4.3 Installation of Erosion Controls

Temporary erosion and sediment controls were installed before construction activities were initiated and were maintained through the duration of the project. Location-specific erosion and sediment controls were implemented at each removal area consistent with the measures described in the Design Report. The specific locations of erosion and sediment controls were selected based on project area-specific considerations related to drainage, topography, and work activities. The selection of erosion and sediment control measures was based on, but not limited to, the scope of removal activities, location and topography, type of ground cover, type of material excavated, anticipated run-off from the project area, and operational/maintenance considerations.

Silt fencing consisting of a non-woven, needle-punched, polyester or polypropylene silt fence was used as the primary means of erosion control around all surface soil disturbances and potential run-off areas. Material specifications for the silt fence were reviewed and approved by ARCADIS prior to use (Appendix D).

Additional erosion control measures included spreading wood chips generated during clearing and grubbing activities throughout the area to reduce wind erosion.

During active work periods throughout the duration of the project, temporary erosion and sediment controls were inspected by the CQA Observer, documented in the daily reports, and maintained and/or modified on a daily basis, consistent with the recommended frequencies outlined in the *Guidebook of Best Management Practices for Michigan Watersheds* (MDEQ 1998). Temporary erosion and sediment controls were maintained, as appropriate, until a final surface cover was established as part of restoration activities.

3.3 Resuspended Sediment Control Structures

Control systems were installed in the river to minimize downstream transport of resuspended materials associated with the removal of sediments and soils. The selected systems had a relatively short setup/breakdown time and could be easily modified to adapt to changes in field conditions. The structures used to control resuspended sediment were capable of functioning under a variety of potential river flow and depth scenarios. Three types of systems were used throughout the TCRA, including turbidity curtains, a combination of turbidity curtains with a flow deflector wall, and fully enclosing steel sheet pile walls.

Inspections of the systems to control resuspended sediment were conducted each day at the beginning of removal activities, in response to visible sediment plumes migrating from the project area, or in response to turbidity levels measured above the action level. Routine daily resuspended sediment control system inspections consisted of a surface assessment of the condition, location, and anchoring of curtains and flow deflector walls. Inspections in response to turbidity levels above the action level metric began with a surface inspection using a boat. Additional inspections were conducted, as appropriate, following higher-flow periods, noticeable turbidity increases outside the system, unexpected system position/behavior, contact with the system by equipment or debris, or other abnormal events. Due to changing water levels and flow velocities, turbidity curtains needed to be adjusted on a regular basis throughout the course of the project. Visible silt plumes were observed on several occasions, but with the exception of the events described in Section 3.5.4.12, did not result in elevated turbidity readings. Upon observation of a visible silt plume, excavation activities were suspended, and resuspended sediment controls were inspected and repaired.

3.3.1 Turbidity Curtains

Turbidity curtains were used extensively throughout the TCRA to control resuspended sediments. Curtains consisted of 22-ounce impermeable fabric, 8-inch diameter closed cell foam floatation devices, and double continuous 5/16-inch chain ballast enclosed in fabric pockets at the bottom edge of the curtain. The curtains had dual center tension cables that were reefable for water depth variation adjustments. One hundred foot curtain segments were joined by metal side connecters and laced grommet edges to create a continuous barrier the length of an entire removal area (Figures 4.1 to 4.8). The curtains were anchored upstream to downstream using galvanized steel fence posts that were driven into the river bed. The downstream and upstream ends of the curtains were attached to the shore. Throughout the project, the curtains were installed or removed as necessary.

Some damage to turbidity curtains occurred during excavation activities as a result of normal wear and tear. Damage was discovered by visual inspection of the curtains, identification of a silt plume escaping the curtain, and/or a turbidity exceedence. Curtains were repaired as soon as possible after damage was identified. Curtains that could not be repaired were replaced and staged for offsite disposal. At the conclusion of the project, curtains that were in good condition and could be reused in the future were decontaminated, folded, and placed in storage.

3.3.2 Flow Deflector Walls

Flow deflector walls were used in conjunction with turbidity curtains to control resuspended sediments in areas where increased water depths or flow velocities were encountered. The use of flow deflector walls reduced the frontal impact of currents on the silt curtain system or completely enclose the work area (Mid-Channel Areas A, B, and C). The Design Report specified Portadam^{TM}-type flow deflectors to construct these walls. However, due to health and safety concerns with working in the water as well as constructability issues related to high flow velocities, ARCADIS decided to use sheet pile to construct the flow deflector walls. The sheet pile could be installed by machinery located on shore and was not affected by high flow velocities.

3.3.3 Fully Enclosed Sheet Pile Walls

Mid-Channel Areas A, B, and C were completely enclosed in steel sheet pile flow deflector walls. Flow deflector walls consisted of 40-foot pairs of Type AZ234 sheet pile driven with a vibratory hammer at an approximate 45-90 degree angle from the river bank's edge into the removal area. Twenty-foot lengths of sheet pile were driven to a depth or approximately 10 feet below the riverbed. The sheet pile then extended the length of the mid-channel areas and angled back into the bank at the downstream portion of the removal area. The walls extended far enough into the river to enclose the removal area (Figures 4.1 to 4.8). At the conclusion of excavation activities in a removal area, sheet pile was removed, decontaminated, and stored for future use.

3.3.4 Resuspended Sediment Monitoring

Turbidity monitoring and surface water sampling were conducted throughout construction activities to monitor the effectiveness of the resuspended sediment control structures. Methods and results are described below.

3.3.4.1 Turbidity Monitoring

Real-time turbidity data were collected daily during removal activities using hand-held meters from one fixed location upstream and from two fixed locations downstream of an active work area. Turbidity was also monitored from one location inside and outside the cofferdam areas during excavation activities in Cofferdam Areas 1 and 2. The upstream location was 200 feet from the upstream work limit, along the general flow path to the work area. The two downstream locations were generally located 200 feet and 300 feet, respectively, from the downstream work limit along the river flow path (Figures 4.1 to 4.8). The specific monitoring locations were adapted based on field conditions and river flow path. Monitoring buoys were installed at the three turbidity monitoring locations to make measurement locations repeatable. USEPA and MDEQ onsite representatives were typically consulted when selecting monitoring locations. The assessments were relative: downstream data were compared to concurrent upstream data to identify increases in turbidity.

Turbidity readings were collected from approximately mid-depth at all locations using a small boat to access data collection points and a YSI 650 MDS multi-parameter probe to collect turbidity readings. The turbidity meter was calibrated, operated, and maintained according to the manufacturer's instructions and was able to measure turbidity at a resolution of +/- 1 nephelometric turbidity unit (NTU).

Turbidity readings were collected from all monitoring locations at the following times:

- Prior to placement of any equipment or materials in a work area.
- Following placement of equipment and materials but prior to removal actions.
- Every hour during removal actions.
- At the beginning of each work day and 2 hours after work was initiated in a given work area.
- At the end of each work day after activities were completed in a given work area.
- For the two stations near the cofferdams, readings were taken hourly during dewatering activities or sheet pile removal.

The measurements collected at the location 200 feet downstream of the work area were used as an early warning of potential exceedances. The measurement collected at the location 300 feet downstream of the work area was compared against the upstream data. If the most downstream (usually approximately 300 feet) turbidity data were two times (2x) the concurrent upstream data, specific steps were initiated until the exceedance was mitigated to below the action level. Due to the proximity to the Plainwell Dam, turbidity monitoring locations could not be established 300 feet downstream of Removal Area 13B and the two cofferdam areas. Turbidity monitoring locations were installed as far downstream as possible (150 to 200 feet) without compromising worker safety by encroaching upon the Plainwell Dam or WCS.

Turbidity monitoring records are included in Appendix F. In the event turbidity reached unacceptable levels (i.e., downstream turbidity data were 2x the concurrent upstream data), a range of mitigation measures was implemented based on the magnitude of the turbidity changes noted.

Mitigation measures included inspecting resuspended sediment control systems for visible plumes, inspecting the turbidity meter to ensure proper function, and slowing or halting excavation activities until turbidity levels returned to acceptable levels. During high river flow events, crews inspected the turbidity curtains twice daily and adjusted the turbidity curtains as needed.

Although visible silt plumes were observed several times, turbidity readings exceeded the action level only once during excavation activities. See Section 3.5.4.12 for additional information.

Downstream turbidity concentrations exceeded twice the upstream readings several times during dewatering activities in Cofferdam Area 1. See Section 3.5.3.17 for additional information.

3.3.4.2 Surface Water Samples

Surface water grab samples were collected for PCB analysis near the turbidity monitoring locations upstream and downstream of the active removal area on a weekly basis to observe spatial and temporal trends in PCB concentrations and were not used as a metric to control the rate of excavation. One sample each was collected from the furthest downstream location (approximately 300 feet downstream) and the upstream location (Figures 4.1 to 4.8). Samples were collected from mid-depth of the river channel using a Kemmerer™ stainless steel bomb sampler at approximately the same time each day (approximately 2 hours after the start of excavation activities). Water quality parameters (temperature, conductivity, and turbidity) were recorded using an YSI 650R multi-parameter probe before collecting the sample.

Between December 12, 2008 and January 29, 2009, surface water samples were collected from shore because all work boats had been demobilized. Samples were collected by wading into the river to the extent practicable and filling the sample jar without the use of the bomb sampler. A rinse blank was not collected for these samples.

Sampling procedures, preservation and handling, and analytical protocols for monitoring of PCBs were consistent with USEPA Method 608, with a quantification level of 0.1 microgram per liter (µg/L) (in accordance with the project-specific QAPP [ARCADIS BBL 2007e]). Samples were analyzed by KAR Laboratories or by TAL. A rinse blank was collected from the bomb sampler during each sampling event. A duplicate sample and matrix spike/ matrix spike duplicate samples (MS/MSD) were collected for one out of every 20 samples.

Between June 2007 and January 2009, 140 surface water samples (70 upstream/downstream pairs), 11 duplicate samples, and 62 rinse blanks were collected. Samples were not collected between Phase 1 and Phase 2 construction activities (January 11, 2008 to March 27, 2008). As noted above, rinse blanks were not collected near the end of Phase 2 construction activities (TS30115 through TS30130) because the samples were collected without the use of a boat or a sampler, as the equipment had been demobilized, and the samples were collected from the shore.

Surface water sample results are summarized in Table 4 and laboratory analytical reports are included in Appendix C-3.

PCBs were detected in nine samples and one duplicate sample. PCBs were not detected in any of the rinse blank samples. Nine of the ten PCB detections were estimated concentrations, as noted by the ‘J’ qualifier. This qualifier means that PCBs were positively identified at a concentration above the method detection limit, but below the quantification limit.

The highest concentration of PCBs (0.51 µg/L) was detected in sample TS30040, collected from 300 feet downstream of Removal Area 12B on June 19, 2008. The PCB concentration of the corresponding upstream sample was 0.059 J µg/L. Although the sample results were not received until two weeks after the sampling event, a visible silt plume was identified downstream of Removal Area 12B approximately one hour after the surface water sample was collected. Based on this observation, excavation activities were immediately suspended, resuspended sediment controls were inspected, and a flow deflector wall was installed at the upstream end of Removal Area 12B to improve the control of resuspended sediment. No additional turbidity readings collected on June 19, 2009 exceeded the action limit at any time. Removal activities in Removal Area 12B resumed on June 23, 2009. These observations and associated responses were recorded in the daily activity reports.

3.4 Installation of Phase 1/ Phase 2 Cofferdams and the WCS

The two cofferdams were installed during the project to isolate the materials to be excavated in the area of the Plainwell Dam, and the WCS was used to control the water level in the Kalamazoo River and improve efficiency of sediment removal activities in the downstream portion of the project area. The Phase 1 Cofferdam was installed first, followed by the WCS, then the Phase 2 Cofferdam.

3.4.1 Cofferdam Installation

The Phase 1 and Phase 2 Cofferdams served to isolate sediment removal activities in Cofferdam Removal Areas 1 and 2 by driving sheet pile along the outer edge of the sediment removal areas, as shown on Figure 5. The basis of design for the Phase 1 and 2 Cofferdams is described in Section 2.4.2 and Appendix H of the Design Report (ARCADIS BBL 2007a).

Pre-installation activities for construction of both cofferdams included sealing sheets; clearing the work area; mobilizing an impact hammer, crane, front-end loader, and barges; installing a temporary dock for access and staging; and fabricating an installation template. The installation template consisted of vertical and horizontal steel H-piles used to maintain alignment of the cofferdams. The template was mobilized throughout the cofferdam installation process.

Type AZ34 steel sheet pile was used for cofferdam construction to provide the necessary bending strength. The AZ interlock (connection between sheets) provided for basic alignment and reduced permeability to inflow (as compared to other sheet pile interlock types). The selection of a "Z" shape sheet pile provided the bending capacity while limiting deflection from earth and hydrostatic loads. Sheet pile lengths of 45 and 50 feet were selected to achieve the necessary embedment depths.

Sheet pile interlocks connected the individual sheets. Larssen-type interlocks (i.e., hook shaped) were used to attach the steel from adjacent piles to each other with minimal space in the interlock for water flow. The sheet pile interlocks were also sealed with Adeka^{TM} P201 joint sealant, which swelled when contacted with water, further reducing the movement of water through the interlocks. Sheets were embedded to depths of approximately 30 feet below the base of excavation to adequately reduce potential underflow conditions.

3.4.1.1 Phase 1 Cofferdam Installation

The Phase 1 Cofferdam isolated the area upstream of the Plainwell Dam between the western bank and the earthen fill dam that existed in the western channel prior to the TCRA in the shape of a triangle (see Figure 5) to facilitate construction of the WCS and associated sediment removal activities. The WCS was installed on the western channel, downstream of the existing earthen embankment (Section 3.4.2). The Phase 1 Cofferdam also allowed for the earthen fill portion of the dam and remaining foundation of the powerhouse to be removed using conventional excavation methods by diverting river flow from the area. This area then served as the initial channel for WCS operations, and ultimately the restored western channel of the Kalamazoo River.

Preparation for installation of the Phase 1 Cofferdam began during the week of August 6, 2007. Sheet pile was installed from southwest to northeast along the alignment of the cofferdam. Sixty-eight pairs of sheet pile were driven between August 14 and September 14, 2007. Eleven of those pairs were located in the overflow weir of the cofferdam. The top-of-wall design elevation was 711 feet National Geodetic Vertical Datum (NGVD) 29 and the overflow weir design elevation was 710.5 feet NGVD 29. A vibratory hammer was used to drive the pile to the design elevation. The weir was constructed by driving an approximately 50 linear-foot section of sheet pile to a lower elevation than the remainder of the wall on either side of the weir. A contingency plan was in place in the event of rapidly rising water levels, which did not occur while the Phase 1 Cofferdam was in place.

Several sheet pile sections could not be driven to design depth using a vibratory hammer due to construction difficulties such as excessive sheet pile interlock friction or subsurface obstructions. These sections were driven to refusal. At that time, the driven depth was reviewed by ARCADIS to determine if the final elevation was acceptable to maintain an adequate factor of safety. If the drive elevation was acceptable, the sheet pile was left in place. If the drive elevation was not acceptable, an impact hammer was used to drive the sheet pile deeper. Fifteen pairs of sheet pile were driven with an impact hammer on September 14, 2007 and installation was considered complete. See Appendix G for a drive record and Figure 5 for additional information. See Section 3.9.1 for a description of Phase 1 Cofferdam removal activities.

3.4.1.2 Phase 2 Cofferdam Installation

The Phase 2 Cofferdam was constructed after former powerhouse structure removal activities were completed (Section 3.5.3.17) and the WCS was operational (Sections 3.4.2 and 3.5.5). The initial Phase 2 Cofferdam sheet pile was driven at a junction pile – this pile and the piles from Station P1 0+00 to approximately P1 0+45 (near the northern end at the mid-channel island) that were driven during Phase 1 remained in place and became part of the Phase 2 Cofferdam system (Figure 5).

Preparation for installation of the Phase 2 Cofferdam began during the week of July 21, 2008. Thirty-one pairs of sheet pile were driven between July 24 and August 8, 2008. Eleven of those pairs were located in the overflow weir of the cofferdam. The top-of-wall design elevation was 710 feet NGVD 29 and the overflow weir design elevation was 707.5 feet NGVD 29. A vibratory hammer was used to drive the pile to the design elevation or to refusal. The weir was constructed by driving an approximately 50 linear-foot section of sheets to a lower elevation than the remainder of the wall on either side of the weir. A contingency plan was in place in the event of rapidly rising water levels, which occurred in September 2008. See Section 3.11 for additional information.

Several sheet pile sections could not be driven to design depth due to construction difficulties such as sheet pile interlock or subsurface obstructions. These sections were driven to refusal, and an impact hammer was mobilized to further embed the sheets. Seventeen pairs of sheets were driven to grade with an impact hammer during the week of August 4, 2008 and installation was considered complete. See Appendix G for a drive record and Figure 5 for additional information. See Section 3.9.2 for a description of Phase 2 Cofferdam removal activities.

3.4.2 WCS Installation

The WCS provided a structure to help regulate upstream water elevations during Phase 2 removal activities. The basis of design for the WCS is described in the Design Report (ARCADIS BBL 2007a). The WCS was installed after the Phase 1 Cofferdam, but before the Phase 2 Cofferdam. Installation of the WCS is described below.

Preparation for the installation of the WCS began during the week of September 17, 2007. Pre-installation activities included sealing sheets, clearing the work area, mobilizing an impact hammer, surveying the area, constructing an earthen berm downstream of the WCS, and setting the installation template. The installation template consisted of steel H-piles used to properly align the sheet piling cutoff wall and H-pile support frame of the WCS. The template was mobilized throughout the WCS installation process.

To provide seepage cutoff, steel sheet piling was installed beneath the H-pile support frame (cut off wall). Steel sheeting was also installed as wing walls on both sides of the weir structure. For the cut off wall, 30-foot length sheet piling was installed as a continuous barrier across the channel, driven to the designed top elevation of 693 feet NGVD 29 beneath the H-pile support frame, and the wall extended to a bottom elevation of 663 feet NGVD 29. In addition, the wing walls at either end of the WCS extended upward to a top elevation of 710 feet NGVD 29. AZ34 steel sheeting was used for the wing and cut off walls.

During the weeks of September 24 and October 1, 2007, the east and west wing walls were installed. Each wall was designed to be 30-foot long. During construction, the east wing wall was extended an additional 14 feet beyond the specified design length to account for a realignment of the wall due to excessive subsurface obstructions encountered during driving and to extend the WCS to the final grade of the earthen embankment, which differed from the pre-construction grade of the earthen embankment. During initial installation of sheet pile, numerous subsurface obstructions were encountered in the area of the east wing wall. To address this issue, the alignment of the WCS was slightly modified, and sheet pile areas were pre-excavated to reduce the impact of obstructions on construction. The sheet pile was placed using a vibratory hammer and driven to refusal. An impact hammer was mobilized during the week of October 8, 2007 to drive the sheets to depth (710 feet NGVD 29).

During the weeks of October 1, 8, and 15, 2007, the cut off wall was installed. The sheet pile was placed using a vibratory hammer and driven to refusal. An impact hammer was mobilized during the week of October 8, 2007 to drive the sheets to depth (see Appendix G for a driving record). Components of the template were removed as sheets were driven to final elevation.

The frame of the weir portion of the WCS consisted of H-piles installed during the weeks of October 15, 22, and 29, 2007 as a series of vertical piles across the western channel of the river. The H-pile design was based on a 25-year flood event, and was 90 linear feet in length. H-piles were installed in between the wing walls and downstream of the cut off wall. The piles were installed in two rows across the river and spaced approximately 6 feet apart in both directions. However, the east-west spacing nearest the east wing wall, between Pile Numbers 15 and 16 was installed to a distance of approximately 7.7 feet. Sixteen 12 x 63 H-pile pairs were driven to a depth of 18 feet below grade (bottom tip elevation of approximately 676 feet

NGVD 29). The top of the H-piles were driven or cut to an elevation of 710 feet NGVD 29. Components of the template were installed as needed and removed as piles were driven to final elevation. One H-pile (Pile Number 10 from west to east) could not be driven to design depth due to a subsurface obstruction. An impact hammer was used to attempt to drive a sacrificial pile through the obstruction; however, the obstruction could not be penetrated. Additional cross-bracing was designed by ARCADIS and installed in the area to support the pile that was not driven to design depth.

Upstream and downstream rows of H-piles (i.e., those that make up the frame) were connected at the top and middle by cross bracing. A steel walkway was installed across the top of the H-piles to provide access to the mid-channel island and spillway structure. Ramps were installed at either end of the H-piles to connect the walkway to the embankment and the western bank. Steel beams were welded along each of the two rows of piles to support the galvanized steel grating walkway. The walkway spanned 6 feet between the two H-pile rows. Hand rails, mid-rails, and toe plates were installed during November and December 2007 spanning the entire length of the walkway to provide safe access to and across the WCS structure.

Six-inch square untreated timber stop logs were installed in the 15 bays flanges in between the H-piles to control water flow through the WCS. Each stop log was trimmed to a length of 6 feet, except in bay 15, where the stop logs were trimmed to approximately 7.7 feet.

To limit seepage, the first several rows of stop logs (i.e., the lowest levels) were bedded in fresh concrete tremied to the river bottom. This approach involved divers placing concrete under water through a pipe or tube (tremie) between the cutoff wall, stop logs, and downstream H-piles. Concrete flow was established by direct connection to a concrete pump. The purpose of this equipment was to enable continuous placement of monolithic concrete underwater without creating turbulence. Once started, the concrete flow was maintained by continually charging the pipe; the tremie pipe was constantly immersed in concrete during placement. This method ensured the integrity of the concrete seal along the river bottom.

The initial row of stop logs, installed during the week of November 26, 2007, was placed as level as possible so subsequent stop logs would be also be as level as possible. On November 28 and 29, 2007, a tremied concrete seal was installed between the sheet pile cutoff wall, first two rows of stop logs, and downstream H-piles to enhance the seepage cutoff capability and scour protection of the WCS. After installation of the remaining stop logs, the concrete was tremied over the alignment of the wall, extending up from the river bottom.

Installation of the downstream erosion protection primarily occurred during the weeks of November 12 and December 3, 2007 and during the weeks of March 20 and 27, 2008. Erosion protection extended approximately 47 feet downstream of the WCS, approximately 125 feet across the width of the western channel, and approximately 14 feet up each of the bank slopes. In 2007, rock-filled gabion baskets were placed immediately downstream of the WCS and extended for the first 12 feet of the erosion protection system. During the concrete tremie pour, divers filled the joint area between the concrete seal and gabion baskets with concrete to prevent falling water from scouring this location. In March 2008, 22.67-foot long articulated concrete block mats, 6 inches high, were placed downstream of the gabion mattresses. Three-foot high jersey barriers were placed downstream of the mats to act as a counter-weir to normalize flow, followed by 9-foot articulated concrete mats. Grout was poured in between the concrete mats and between the gabions and mats. A non-woven geotextile fabric was placed beneath the entire erosion protection system.

Gabion baskets consist of wire mesh baskets filled with approximately 3-inch stone. These units effectively formed an armor layer to resist the impact and abrasive action of the discharge flow. River run rock was installed along the banks of the western channel to protect those areas from erosive forces downstream of the WCS.

Major WCS construction activities were completed during the week of December 10, 2007. The earthen berm used for access was removed along with project equipment. The WCS was not used to control upstream river elevations at this time, due to the presence of the Phase 1 Cofferdam. Significant construction activities were then suspended during January and February 2008.

WCS construction activities resumed in March 2008. At that time, the additional scour protection described above, and a stop log retrieval system were installed. Due to the size, weight, and safety elements associated with the stop log system, logs were not removed by hand, but were removed by a trolley-mounted ½-ton hoist and chain that operated along a steel beam installed next to the overhead walkway. Stop log removal was initially performed using a grapple attached to a center-pull double hook chain host, but was later replaced by a pneumatically-fired log tong positioned in the middle of the stop log. Installation of the WCS was completed on April 16, 2008. At that time the Phase 1 Cofferdam hydraulically isolated the WCS from the Kalamazoo River. See Section 3.5.5 for a description of WCS operation and Section 3.9.3 for a description of WCS removal activities.

3.4.3 Deflection Surveys

A deflection survey was conducted monthly while the Phase 1 and Phase 2 Cofferdams and WCS were in place to monitor any potential movement of the structures' components due to river forces. Deflection survey results were compiled and reviewed by ARCADIS structural and geotechnical engineers to continually evaluate the performance of the cofferdams and WCS. No performance deficiencies were identified by the deflection surveys. Deflection survey results are provided in Appendix H.

3.5 Soil and Sediment Removal

Areas to be removed as a part of the TCRA were delineated in the Design Report (ARCADIS BBL 2007a) based upon a review of analytical studies performed on sediments, bank soils, and floodplain soils.

Background

As described in Section 1.2 of the Design Report, the former Plainwell Impoundment has been the focus of an extensive series of investigations by ARCADIS, MDNR, and USEPA since 1993. The most recent PCB data were generated during a sampling effort conducted by ARCADIS in 2006. A variety of targeted studies of the impoundment were also conducted in 2005 and 2006 to further characterize site topography, bank stability/disposition, flow hydrodynamics, equipment accessibility, and habitat quality. The results of these investigations were used to define the horizontal and vertical extents of soil excavation. The results of the delineation process were summarized in Section 2.1 and Drawings SR-1.1 through SR-1.8 of the Design Report (ARCADIS BBL 2007a). Soil excavation was performed to these extents and confirmed complete per the requirements of the Design Report (ARCADIS BBL 2007a).

Excavation Technique

Excavation was generally performed from the top-of-bank using an open bucket excavator equipped with a real time kinematic global positioning system (RTK GPS). Barge-based excavation or temporary earthen bridges were constructed to excavate soil and sediment located outside the 40-foot reach of the excavator.

Excavation of submerged sediment was performed from upstream to downstream in each removal area. The excavator first removed individual buckets of material from the extent of the excavation, working back perpendicularly to the shore. Once this was completed, the excavator bucket scraped the exposed surface at a 45-degree angle from the extent of excavation back to the shore. This procedure was designed to remove any material that remained in between bucket excavation rows. USEPA and MDEQ utilized a combination of inspection methods to document and approve completion of excavation. These inspection methods included review of RTK GPS data, physical probing, and use of an underwater camera.

Excavated soil and sediment was generally loaded into off-road trucks and hauled to the nearest staging area for processing and disposal. As construction activities warranted, material was staged in floodplain areas for dewatering prior to transport to the nearest staging area for processing and disposal. Dry material was loaded directly into gravel-train trucks for transport to the offsite disposal facility. See Sections 3.6 and 3.7 for additional information regarding soil and sediment processing and disposal.

Soil and sediment removal areas were divided into five general categories:

1. Near-Shore Sediments
2. Mid-Channel Sediments
3. Bank Soils
4. Floodplain Soils
5. Islands

Sediment and soil removal areas were divided into 13 general areas, numbered 1 through 13, with Removal Area 1 being the most upstream removal area and Removal Area 13 being the most downstream removal area. Removal areas were further subdivided to facilitate efficiencies during excavation work. The letter “A” indicates the portion of the removal area located along the northern bank of the river (e.g., 11A), while the letter “B” indicates the portion of the removal area located along the southern bank of the river (e.g., 11B). Not all 13 removal areas included portions on both sides of the river. If only one bank was removed, an ‘A’ or ‘B’ notation was not included (e.g., Removal Area 1). An additional number was added to the end of certain removal area designations (e.g., 11A1), as appropriate, to identify smaller sub-areas. Soil and sediment removal work progressed from upstream to downstream, beginning with Removal Area 1. The river stationing increased downstream to upstream, with Station 0+00 located at the Plainwell Dam. Stationing is presented in hundreds of feet upstream of the dam.

Mid-Channel sediment areas and islands were delineated independently. Removal Areas 1 through 13 contained a combination of near-shore sediment, bank soils, and/or floodplain soils. Removal activities in these areas are discussed in the following sections.

Sediment and soil removal activities were performed in two phases between May 2007 and January 2009. Phase 1 removal activities were performed between May 2007 and January 2008; Phase 2 removal activities were performed between March 2008 and January 2009. Removal of soil and sediment generally progressed from upstream to downstream and both sides of the river were excavated simultaneously throughout much of the TCRA.

At the completion of the TCRA, approximately 126,700 cy of material had been removed and disposed at commercial offsite landfills. This material consisted of approximately 20,860 cy of TSCA material and 105,840 cy of non-TSCA material.

3.5.1 Excavation Confirmation

Confirmation monitoring was performed to verify that the design specifications had been achieved and varied according to the work area being monitoring. Confirmation monitoring was conducted immediately following completion of excavation so that additional response actions, if necessary, could be taken quickly, while the equipment was nearby.

3.5.1.1 Confirmation Sampling

Completion of soil excavation to the extent defined in the Design Report (ARCADIS BBL 2007a) was confirmed through PCB soil confirmation sampling for bank, floodplain, upland areas, and Island 3. The purpose of the confirmation sampling was to verify that no unacceptable PCB concentrations were left behind within the excavation boundaries. Therefore, confirmation sampling affected the depth of excavation, but did not affect the lateral extent of removal which was determined using historical data before completion of the Design Report (ARCADIS BBL 2007a). The PCB sampling performance standard was generally 5 mg/kg. Because Removal Area 1 was located near a residential area, the PCB confirmation sampling performance standard was 4 mg/kg. Confirmation sample locations for each removal area (as appropriate) were surveyed to document sample locations.

3.5.1.2 Surface Elevation Confirmation

Excavation of sediment in the near-shore, mid-channel, and Islands 1 and 2 was confirmed by documenting the final surface elevation and comparing it to the neat line established in the Design Report (ARCADIS BBL 2007a). Surface elevation measurements were recorded at specific transect points as described below using a RTK GPS-equipped excavator.

3.5.1.2.1 RTK GPS

The position of the excavator bucket as it removed sediments was displayed using a RTK GPS as manufactured by Topcon (Model 3DXi). A RTK GPS system was mounted on each of the two RTK GPS-equipped excavators used during the project and communicated with a surveyed base station installed in an open area away from the river. The location of the base station changed as work progressed through the removal areas.

Three position sensors were mounted on the cab, boom, and bucket of each excavator. The three sensors worked together to triangulate the position of the bucket. These signals were relayed to the base station which calculated errors from cover, rainfall, atmosphere, and other factors to improve accuracy.

3.5.1.2.2 RTK GPS Calibration

Prior to use of the RTK GPS unit, an initial calibration was completed by the manufacturer's authorized representative. The initial calibration included equipment measurements and installation of the tilt sensors. During removal activities, vertical and horizontal checks were performed twice daily – once prior to commencing excavation activities and once during the day. Vertical and horizontal checks were completed by placing the excavator bucket on a pre-surveyed check-point located at a concrete pad in the project area.

Additional calibrations were completed by a manufacturer's authorized representative if one of the following occurred:

- Within 2 months after initial calibration and at least 2 months after each follow-up calibration.
- Upon equipment change or modification which affects the tilt sensor placements, including changes to the excavator bucket.
- When the vertical and horizontal twice daily checks were not within the specified manufacturer's horizontal tolerance limits of $\pm$ 0.2 feet.

RTK GPS calibration logs are included in Appendix I.

3.5.1.2.3 RTK GPS Data Collection

The vertical and lateral extents of excavation were defined in Contract Drawings SR1.1 to SR1.8 in the Design Report. Cross-sections of the excavation plan were converted to a three dimensional surface known as a triangular irregular network (TIN) that was viewed in real-time by the excavator operator.

The display mounted within the cab of the excavator showed the TIN as a plot of the maximum depth of penetration of the bucket versus the design neat line. Excavation proceeded until either the pre-impoundment river bottom/native material was encountered or the neat line was reached.

Although bucket elevation data were displayed in real time, the data were not continuously collected, which would have resulted in an overabundance of data. To generate a manageable amount of data, an elevation collection protocol was established to evaluate completion of excavation.

For Phase 1 construction activities (i.e., 2007 construction season), elevation data were collected and processed at transects aligned every 50 feet throughout the sediment excavation areas. Three data points were collected on each transect from the in-water extent of excavation (20 to 40 feet from shore, depending on the removal area), the toe-of-slope near the river edge, and the midpoint between the other two locations. The data points from the 50-foot transects were plotted to verify, in conjunction with the real-time data reviewed by the excavator operator, that the neat line had been reached.

The elevation collection protocol was modified for Phase 2 construction activities (i.e., 2008 construction season) to collect additional data that confirmed the completion of excavation. Instead of collecting data on 50-foot transects, elevation data were collected every 25 feet. Four data points were collected from each 25-foot transect: from the in-water extent of excavation (20 to 40 feet from shore, depending on the removal area), the toe-of-slope near the river edge, the top-of-bank, and one point located between the toe-of-slope and top-of-bank. The surface elevation data presented in Figures 4.1 to 4.8 represent the coordinate data collected from the in-water extent of excavation and the toe-of-slope. These two points were used to confirm that excavation was completed in the near shore and mid-channel areas to the neat line. The top-of-bank and intermediate bank coordinate data were collected to document as-built excavation elevations and are included in Appendix J.

The lateral extent of excavation was performed to the Control Points documented in Contract Drawings SR1.1 to SR1.8 of the Design Report. These Control Points are included on Figures 4.1 to 4.8 and in Appendix K.

3.5.2 Removal Areas

The definition of each removal area and the type of excavation confirmation performed varied by the five general categories of soil sediment removed. Mid-channel and Island areas were individual areas, while removal areas could consist of floodplain, bank, and/or near-shore sediment removal areas.

3.5.2.1 Near-Shore Sediment Removal Areas

Near-shore sediment removal areas include river sediments located within approximately 40 feet outward from the pre-removal top of the river bank. The near-shore sediments that were removed generally included accessible (i.e., from the bank) sediment deposits greater than 6 inches thick.

A neat line was established to delineate the lateral and vertical extent of excavation. The vertical extent of the neat line was based on the interpolated pre-impoundment channel bottom elevations identified in the Design Report. The lateral extent of the neat line was based on material that was accessible from the bank. Near-shore sediments were excavated to that neat line, which was set below PCB-containing sediment particularly in the downstream end of the former impoundment where the deepest sediment and highest near-shore sediment PCB concentrations were present

Excavation depth or lateral extent was modified from the neat line established in the Design Report if either of the following conditions were present:

- Near-shore sediment removal stopped at higher elevations than those indicated in the Design Report if pre-impoundment channel bottom materials (i.e., coarser and/or denser sediments) were encountered at higher elevations.

- Near-shore sediments were generally excavated 40 feet outward from the pre-construction top-of-bank. If this could not be conducted safely, if an obstruction was encountered, or if soft sediment was not present within the near-shore area, the 40-foot reach was modified. The regulatory agency onsite representatives were consulted to revise the extent of the near-shore sediments that were to be removed at that location.

The removal in near-shore sediment areas was confirmed by the RTK GPS system as excavation activities were being conducted. For Phase 1 construction activities, near-shore sediment removal areas were defined as the area that is bounded on the landward side by the dam-in median water elevation and on the river side by the extent of excavation. This area was redefined for the Phase 2 construction activities as described in Section 2.3.3. During Phase 2 construction activities, near-shore sediment removal areas were defined as the area bounded on the landward side by the toe-of-slope and on the river side by the extent of excavation.

Near-shore removal was performed to the depth of the neat line designed to represent the elevation of the estimated pre-impoundment river bottom. In these cases, the removal segment was evaluated as a whole to determine whether the removal objective was achieved. When the substrate at that location after removal was gravel and cobbles, it was interpreted as evidence of the former river bottom, and no further action or confirmation monitoring was necessary. The USEPA and MDEQ onsite representative was consulted at these times to confirm completeness of excavation in the area.

The RTK GPS on the excavator was used to continuously compare the current position of the bucket to the design neat line. Once the prescribed neat line or former river bottom had been reached, the position of the excavator bucket was recorded using the RTK GPS on the excavator at three or four designated locations along 25- or 50-foot intervals. As agreed to by all parties, additional material was removed in some areas to more closely approximate the actual parent bed material. This was generally performed if more than 6 inches of sediment remained between the neat line and the pre-impoundment river bottom. The lateral extents and depths of removal within these areas are shown on Figures 4.1 to 4.8. RTK GPS data collected for confirmation monitoring are included in Appendix J.

3.5.2.2 Mid-Channel Sediment Removal Areas

Mid-channel sediments are river sediments located more than 40 feet from the pre-removal top of river bank. The mid-channel sediments that were removed included those deposits known to contain PCB concentrations greater than 50 mg/kg. Additional mid-channel sediments were removed from between the sheet pile cofferdams and Plainwell Dam to facilitate regrading of the western channel and/or removal of portions of Plainwell Dam.

Three mid-channel deposits (Mid-Channel Areas A, B, and C) were removed as a part of the TCRA. A neat line was established based on the interpolated pre-impoundment channel bottom elevations identified in the Design Report. Mid-channel sediments were excavated to that neat line. Mid-Channel Areas A, B, and C were excavated to the interpolated pre-impoundment channel bottom. Methods for observing potential scour of these mid-channel deposits prior to their excavation are discussed in Section 3.5.5.

In addition to the three mid-channel removal areas described above, mid-channel sediments were also removed from areas located immediately upstream of the former Plainwell Dam powerhouse structure (Cofferdam Area 1) and upstream of the former Plainwell Dam spillway (Cofferdam Area 2). This removal included excavation of sediments between the proposed cofferdams and Plainwell Dam. Additional sediments were removed, as needed, to facilitate regrading the western channel and removing the existing concrete powerhouse structure located in Cofferdam Area 1. The lateral extents and depths of removal within these areas are shown on Figures 4.1 to 4.3. RTK GPS data collected for confirmation monitoring is included in Appendix J.

Excavation in the three mid-channel areas was confirmed using the same protocols and procedures used for excavation of near-shore sediment, as described in Section 3.5.2.1. Mid-channel removal was performed to the depth of a neat line. Similar to near-shore sediment removal areas, once the prescribed neat line or former river bottom had been achieved, the position of the excavator bucket was recorded at pre-determined locations using the RTK GPS on the excavator. As agreed to by all parties, additional material was removed in some areas to more closely approximate the actual parent bed material. This was generally performed if more than 6 inches of sediment remained between the neat line and the pre-impoundment river bottom.

3.5.2.3 Bank Soil Removal Areas

Bank soil removal areas include soil materials located on the face of the pre-removal river banks above the pre-removal (dam-in) median flow water elevation and below the pre-removal top of bank. Bank soils that were removed included those soils adjacent to targeted sediment removal areas that were removed to create a stable river bank.

Where conditions permitted, targeted bank soils were removed and/or unstable and over-steepened river banks were laid back at slopes no steeper than 3H:1V (horizontal: vertical) to reduce the potential for future erosion and sloughing, and to improve conditions for restored habitat features. Approximately 7,625 linear feet of river bank was addressed as part of the TCRA. The depth of soil removal in each targeted area varied and is depicted on Figures 4.1 to 4.8.

Where conditions allowed, a 30-foot wide “clean buffer” was excavated back from the pre-construction top-of-bank. The depths of removal within clean buffer areas were established to remove soils containing observed PCB concentrations greater than 5 mg/kg. The excavated back slopes of clean buffer areas were sloped at 3H:1V to meet existing grade. The nominal width of these buffer areas was measured from the location of the existing top-of-bank to the point on the 3H:1V excavated back slope representing the maximum recorded depth of soils containing observed PCB concentrations greater than 5 mg/kg.

The RTK GPS system was used to compare the position of the excavator to the neat line established in the Design Report. After the proposed excavation depths had been achieved, PCB-containing exposed sediments were sampled to verify that no PCB concentrations that exceeded the performance standard remained. These removal areas included varying widths of the bank that extended outward from the river and were bounded on the landward side by the top-of-bank. The river side boundary of the bank soil areas differed during the two construction seasons. During the Phase 1 construction activities, and according to the Design Report, the river side boundary of the bank soil sampling area was the dam-in median line. Between the 2007 and 2008 construction seasons, this boundary was redefined as the toe-of-slope within the river as described in Section 2.3.3.

For the bank soil removal areas, a confirmation sampling 75-foot long grid divided into 15-foot by 5-foot nodes was established. Grid length was modified to adjust for actual bank lengths.

Immediately following excavation of a bank soil grid, five nodes were randomly selected for sampling. The random pattern was modified in the field (with concurrence of regulatory agency oversight personnel) if excessive spatial bias existed within a grid. The random pattern was not modified during Phase 1 construction activities, but was modified during Phase 2 construction activities. Sample locations were staked in the field and surveyed with a roving GPS unit. Soil samples were collected using Lexan tubing from approximately 3 to 6 inches below the floor of the excavation to obtain an undisturbed sample. The samples from the five nodes were composited and submitted to the laboratory for PCB analysis. Photographs and sample descriptions were recorded for each sample. When possible, sample grids for areas containing TSCA material were aligned individually from non-TSCA areas. In the event that TSCA and non-TSCA material were both present within a single 75-foot long grid, the areas were sampled individually and five locations from each area were composited to generate a TSCA sample and a non-TSCA sample. Samples from TSCA grids were identified by the grid ID (i.e. Removal Area 11A, Grid 1 BS TSCA is a bank sample from a TSCA area, and Removal Area 11A, Grid 1 BS is a bank sample from a non-TSCA area). The basis for determining TSCA material is described in Section 2.3.1.1.

If the laboratory data confirmed that the PCB concentration for the composite sample was less than or equal to 5 mg/kg, the excavation of the grid was considered complete, and no additional excavation was required. If the PCB concentration was greater than 5 mg/kg, an additional 6 inches of material was removed from the entire grid area. After the additional material was removed, soil samples were again collected from five randomly selected grid nodes, composited, and submitted for PCB analysis. If the PCB concentration from the second round of sampling was less than or equal to 5 mg/kg, no further excavation of the area was required; however, if the PCB concentration was greater than 5 mg/kg, an additional 6 inches of material was removed from the entire area. This process continued until either the PCB concentration of the composite sample was less than 5 mg/kg or sand/cobbles indicative of native riverbed were encountered. The regulatory agencies were consulted to confirm completeness of excavation when native riverbed was encountered.

Sample locations were surveyed using the State Plane, North American Datum 1983 (NAD 83), Michigan South Zone for horizontal datum and NGVD 29 for vertical datum. All analytical laboratory sampling and analysis were conducted in accordance with the project-specific QAPP (ARCADIS BBL 2007e). Soil samples were analyzed by KAR Labs for PCBs within 24 hours so that response actions, if necessary, could be implemented before equipment was removed from the area. The results of soil sampling are included on Figures 6.1 to 6.10 and Table 5. Laboratory analytical reports are included in Appendix C-4.

3.5.2.4 Floodplain Soil Removal Areas

Floodplain soil removal areas included soil materials located in the floodplain (i.e., exposed former sediments) outward from the pre-removal top-of-bank.

Based on the PCB data summarized in the Design Report, seven distinct upland floodplain areas were excavated to remove soils containing PCB concentrations greater than 50 mg/kg. These seven floodplain removal areas were identified as Upland Removal Areas 3A1, 3A2, 4B1, 6B1, 10B1, 11A1, and 12A1.

After excavating the floodplain areas to the neat line using the RTK GPS equipped excavator, a confirmatory sampling and analysis procedure similar to that employed for the bank removal areas was implemented. The removal areas within the floodplain that comprised PCB-containing exposed sediment were sampled after construction to verify that no unacceptable PCB concentrations that exceeded the performance standard were left behind. These removal areas included varying widths of the floodplain that extended outward from the river (the clean buffer area), as well as the upland areas. The floodplain soil removal areas were bounded on the river side by the top-of-bank.

For the floodplain soil removal areas, a nominal 75-foot by 75-foot sample grid divided into 15-foot by 15-foot nodes was established. Using procedures parallel to those used for bank sediment sampling, immediately following excavation of a floodplain soil grid, five nodes were randomly selected for sampling. The random pattern could be modified in the field (with concurrence of regulatory oversight personnel) if excessive spatial bias existed within a grid. The random pattern was not modified during Phase 1 construction activities, but was modified during Phase 2 construction activities. Samples from within the selected grid nodes were collected using Lexan tubing from approximately 3 to 6 inches below the floor of the excavation to obtain an undisturbed sample. Sample locations were staked in the field and surveyed with a roving GPS unit. The samples from the five nodes were documented, photographed, composited, and submitted for PCB analysis.

When possible, sample grids for areas containing TSCA material were aligned individually from non-TSCA areas. In the event that TSCA and non-TSCA material were both present within a single 75-foot long grid, the areas were sampled individually. Five locations from each area were composited to generate a TSCA sample and a non-TSCA sample. Samples from TSCA grids were identified by the grid ID. During the 2007 construction season, the alphabetic identifier ‘A’ was added to the grid ID for non-TSCA samples and the identifier ‘B’ was added to the grid ID for TSCA samples. For example, Removal Area 3B, Grid 3A is an area containing non-TSCA material prior to excavation and Removal Area 3B, Grid 3B is an area containing TSCA material prior to excavation. During the 2008 construction season, a TSCA label was added to the grid ID number (i.e., Removal Area 11A, Grid 1 TSCA is a floodplain soil sample from a TSCA area, and Removal Area 11A, Grid 1 is a floodplain sample from a non-TSCA area). The basis for determining TSCA material is described in Section 2.3.1.1.

With the exception of Removal Area 1, if the laboratory data confirmed that the PCB concentration for the composite sample was less than or equal to 5 mg/kg, the excavation of the grid was considered complete, and no additional excavation was required. Additional sampling and excavation was completed as described for bank soils in Section 3.5.2.3. The results of soil sampling are included on Figures 6.1 to 6.10 and Table 5. Laboratory analytical reports are included in Appendix C-4.

Because Removal Area 1 was located near residential properties, soils were excavated until the PCB concentration in the composite sample was less than 4 mg/kg. Confirmation sampling procedures in Removal Area 1 did not differ in any other manner.

Depending on the size and configuration of the floodplain soil removal areas, the sampling grid size, shape, and node density was modified to better align with the specific configuration of each area, with five randomly chosen samples consistently collected from each gridded area regardless of grid size, shape, or node density. For areas where the spatial configuration did not accommodate a 75-foot by 75-foot grid, the grid was adjusted to fit the shape of the work area and the number of soil samples collected for compositing was adjusted as necessary; however, even in irregular grids the samples were collected from nodes representative of no greater then approximately 225 square feet. For example, flow deflector walls were installed at a 45 degree angle at the upstream end of some removal areas downstream of the US 131 Bridge. In some instances, the flow deflector wall transected the most upstream sampling grid of the removal area. This area was then split into two sampling grids, each divided into 15-foot by 15-foot nodes, and five random nodes were composited for sampling. In Removal Area 12A, irregular grids were aligned to facilitate equipment access to the area and sequencing of TSCA and non-TSCA removal areas. These irregular grids did not exceed an area of 5,625 square feet. The grids were divided into nodes, and five random nodes were sampled and composited.

3.5.2.5 Island Removal Areas

Soil materials from two islands located just downstream of the US 131 Bridge (Islands 1 and 2) and one island just upstream of the US 131 Bridge (Island 3) were also removed as part of the TCRA. Islands 1 and 2 were excavated to a neat line established approximately 6 inches above the interpolated pre-impoundment channel bottom as confirmed using the RTK GPS procedure for near-shore sediments. Island 3 was excavated and confirmed using the procedure established for floodplain soils. The results of soil sampling are included on Figures 6.1 to 6.10 and Table 5. Laboratory analytical reports are included in Appendix C-4.

3.5.3 Phase 1 Removal Activities

Phase 1 removal activities included sediment/soil removal at Removal Areas 1 to 8; Islands 1, 2, and 3; and Cofferdam Area 1. Concrete and other material from the former Plainwell Dam and powerhouse structures were also removed during Phase 1. Approximately 3,010 cy of TSCA and 36,015 cy of non-TSCA material were disposed of at offsite commercial landfills during Phase 1. Generally, excavation occurred upstream to downstream. This was true for Phase 1 removal activities except in the instance of Removal Area 6A as described in Section 3.5.3.11. The following sections summarize removal activities in each area. Bank stabilization activities and habitat reconstruction are discussed in Section 3.8.

3.5.3.1 Removal Area 1

Vegetation was cleared from Removal Area 1 to provide access for construction activities in May 2007. Turbidity curtains were installed along the entire removal area in June 2007 to control resuspended sediments. Excavation of near-shore and floodplain soil/sediment in Removal Area 1 was performed between June and July 2007. Both TSCA and non-TSCA materials were removed from this area and transported to Staging Area 1N for processing and disposal.

Approximately 930 linear feet of floodplain material was excavated to the neat line from Removal Area 1. The removal area was divided into 12 confirmation sampling grids. Laboratory data confirmed that PCB concentrations in one grid (Grid 5) exceeded the PCB performance standard of 4 mg/kg. See Figure 6.1 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

An additional 6 inches of material were removed from Grid 5 on June 18, 2007, and the grid was resampled (K55238). The PCB concentration detected in sample K55238 (2.3 mg/kg) did not exceed the performance standard of 4 mg/kg. USEPA approved the completion of excavation in this area.

The PCB concentration collected from Grid 12 (K55244, 2.7 mg/kg) did not exceed the PCB performance standard (5 mg/kg). However, USEPA collected a split sample from Grid 12; the PCB concentration detected in the USEPA split sample (APS-062607-01-SD, 4.9 mg/kg) exceeded the PCB performance standard.

Grid 12 was re-excavated based on the PCB concentration detected in the USEPA split sample. Six additional inches of material were removed from Grid 12 on June 26, 2007. After the excavation was completed, ARCADIS attempted to collect a confirmation sample. However, all Lexan® tubes were driven to refusal and no material could be collected from any of the five nodes. As such, no sample was collected. USEPA determined that the excavation in this area was complete to native riverbed elevation, and that no additional excavation or sampling was required.

On June 23, 2007, one soil sample (K55242) and one duplicate sample (K55243) were collected from Removal Area 1, Grid 11. According to the analytical results, the total PCB concentrations in the sample and in the duplicate were 1.1 mg/kg and 4.4 mg/kg, respectively. Because the latter concentration exceeded the performance standard of 4 mg/kg, both samples were reanalyzed to resolve the discrepancy. According to the reanalysis, the sample and duplicate PCB concentrations were 2.4 mg/kg and 1.7 mg/kg, respectively. These results were reported to the USEPA On-Scene Coordinator (OSC), who determined that excavation in the area was complete.

Excavation of near-shore sediments in Removal Area 1 was not included in the Design Report. As described in Section 2.3.2.1, USEPA directed the excavation of additional near-shore sediment in this area. The additional excavation included materials from within 20 to 40 feet of the northern river bank. Under the supervision of USEPA, approximately 350 cy of material was excavated from the area on July 17 and 20, 2007. Excavation was performed using near-shore sediment excavation techniques and confirmed by RTK GPS. The onsite USEPA representative walked the excavation area, and approved the completion of removal activities. See Figure 4.8 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.2 Removal Area 2A

Vegetation was cleared from Removal Area 2A to provide access for construction activities, and turbidity curtains were installed along the entire length of Removal Area 2A in June 2007. Excavation of TSCA and non-TSCA soil/sediment from the near-shore and floodplain of Removal Area 2A was performed between June and July 2007. Excavated materials were transported to Staging Area 1N for processing and disposal.

Approximately 395 linear feet of floodplain material was excavated to the neat line. Removal Area 2A was divided into six confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.2 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 170 linear feet of near-shore material was removed to the neat line and confirmed by RTK GPS. No problems were encountered during excavation, and no additional excavations of near-shore material occurred. See Figure 4.7 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.3 Removal Area 2B

The original scope of the TCRA did not include removal of material indentified as Area 2B. On July 10, 2007, the KRSG received written direction from USPEA to remove near-shore material in the area designated as Removal Area 2B, as described in Section 2.3.2.2.

Vegetation was cleared from Removal Area 2B to provide access for construction activities in July 2007. Turbidity curtains were installed along the entire removal area in August 2007 to control resuspended sediments. Approximately 350 linear feet of material between elevations 710 and 712 was removed between stations 65+50 and 69+00 in August 2007. Excavation elevations were confirmed by RTK GPS and excavated materials were transported to Staging Area 2S for processing and disposal. See Figures 4.7 and 4.8 for depictions of the sediment excavation as-built, and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.4 Removal Area 3A

Vegetation was cleared from Removal Area 3A to provide access for construction activities in May 2007. Turbidity curtains were installed along the entire removal area in June 2007 to control resuspended sediments. Excavation of non-TSCA floodplain sediments/soils was performed between June and July 2007. Excavated materials were transported to Staging Area 1N for processing and disposal.

Approximately 555 linear feet of floodplain material was excavated to the neat line, and Removal Area 3A was divided into seven confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.2 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.5 Upland Removal Areas 3A1 and 3A2

Vegetation was cleared from Upland Areas 3A1 and 3A2 in June 2007. Resuspended sediment controls were not necessary in the upland floodplain areas because they were not located adjacent to the river. Excavation of non-TSCA floodplain sediments/soils was performed in July 2007. Excavated materials were transported to Staging Area 1N for processing and disposal.

Approximately 100 and 150 linear feet of floodplain material was excavated to the neat line from Upland Areas 3A1 and 3A2, respectively. One confirmation sample was collected from each Upland Area.

Confirmation sample K55270 was collected from Upland Area 3A2. According to laboratory data, a PCB concentration of 26 mg/kg was detected in the sample. Approximately 8 additional inches of material was removed from Upland Area 3A2 on July 27, 2007, and the grid was resampled (K55238). The PCB concentration detected in sample K55276 (0.64 mg/kg) did not exceed the performance standard of 5 mg/kg. See Figure 6.2 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.6 Removal Area 3B

Vegetation was cleared from Removal Area 3B to provide access for construction activities in July 2007. Turbidity curtains were installed along the entire removal area in August 2007 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore and floodplain sediments/soils was performed between August and September 2007. Excavated materials were transported to Staging Area 2S for processing and disposal.

Approximately 570 linear feet of floodplain material was excavated to the neat line. Removal Area 3B was divided into ten confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. However, USEPA collected a split sample from Removal Area 3B, Grid 3B, a TSCA sediment area. Although the PCB concentration detected in the confirmation sample (2.6 mg/kg) was below the performance standard of 5 mg/kg, the PCB concentration detected in the USEPA sample (7.8 mg/kg) exceeded the performance standard.

On September 7, 2007, soft sediment deposits (3 to 6 inches in thickness) were removed from Removal Area 3B, Grid 3B until the native riverbed was encountered. Because the sand and gravel riverbed could not be sampled, a confirmation sample was not collected. The USEPA OSC was onsite during excavation activities and confirmed that excavation in the area was complete. See Figure 6.2 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data is included in Appendix C-4.

Approximately 118 linear feet of additional near-shore material was excavated to the neat line and confirmed by RTK GPS. No problems were encountered during excavation, and no additional excavations of near-shore material occurred. See Figure 4.7 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.7 Removal Area 4A

Vegetation was cleared from Removal Area 4A to provide access for construction activities in May 2007. Turbidity curtains were installed along the entire removal area in June 2007 to control resuspended sediments. Excavation of non-TSCA floodplain soils was performed in July 2007. Excavated materials were transported to Staging Area 1N for processing and disposal.

Approximately 655 linear feet of floodplain material was excavated to the neat line. Removal Area 4A was divided into nine confirmation sampling grids. With the exception of Grid 5, PCB concentrations were below the performance standard of 5 mg/kg in the confirmation sampling grids in Removal Area 4A.

Sample K55267 was collected from Removal Area 4A, Grid 5. According to the laboratory results, a PCB concentration of 7.5 mg/kg was detected in the sample. On July 20, 2007, an additional 6 inches of material was removed from this area, and sample K55268 was collected on July 24, 2007. A PCB concentration of 4.8 mg/kg was detected in sample K55268. To ensure completeness of removal activities, all remaining soft sediments in Removal Area 4A, Grid 5 were excavated on July 26, 2007 until the native riverbed was encountered. Because the sand and gravel riverbed could not be sampled, a confirmation sample was not collected. The USEPA OSC was onsite during excavation activities and determined that excavation in the area was complete. See Figure 6.3 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.8 Removal Area 4B

Vegetation was cleared from Removal Area 4B to provide access for construction activities in July 2007. Turbidity curtains were installed along the entire removal area in August 2007 to control resuspended sediments. Excavation of non-TSCA floodplain, bank, and near-shore sediments/soils was performed in August 2007. Excavated materials were transported to Staging Area 2S for processing and disposal.

Approximately 610 linear feet of floodplain and 320 feet of bank material were removed. Removal Area 4B was divided into nine (eight floodplain and one bank) confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.3 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 300 linear feet of near-shore material was removed to the neat line and confirmed by RTK GPS. No problems were encountered during excavation, and no additional excavations of near-shore material occurred. See Figure 4.6 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.9 Upland Removal Area 4B1

Vegetation was cleared from Upland Area 4B1 in July 2007. Resuspended sediment controls were not necessary in the upland floodplain area. Excavation of non-TSCA floodplain soils were performed in August 2007. Excavated materials were transported to Staging Area 2S for processing and disposal.

Approximately 50 linear feet of floodplain material was excavated to the neat line, and one confirmation sample was collected. The PCB concentration in the confirmation sample did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.3 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.10 Removal Area 5

Vegetation was cleared from Removal Area 5 to provide access for construction activities in June 2007. Turbidity curtains were installed along the entire removal area in July 2007 to control resuspended sediments. Excavation of non-TSCA floodplain soils was performed between July and August 2007. Excavated materials were transported to Staging Area 1N for processing and disposal.

Approximately 225 linear feet of floodplain material was excavated to the neat line. Removal Area 5 was divided into four confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.3 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.11 Removal Area 6A

Removal Area 6A is located downstream of Removal Area 5, however it was excavated prior to excavation of Removal Area 5 and Island 3 because the area would have been difficult to access by land once Island 3 and Removal Area 5 had been removed. An access road was constructed from Removal Area 5, across Island 3, to Removal Area 6. Removal Area 6 was excavated, the bank stabilized, and the access road removed as equipment was pulled from the area.

Vegetation was cleared from Removal Area 6A to provide access for construction activities in June 2007. Turbidity curtains were installed along the entire removal area in June 2007 to control resuspended sediments. Excavation of non-TSCA floodplain and near-shore sediments/soils was performed between July and August 2007. Excavated materials were transported to Staging Area 1N for processing and disposal.

Approximately 435 linear feet of floodplain material was excavated to the neat line. Removal Area 6A was divided into seven confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.4 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 445 linear feet of near-shore material was removed to the neat line, where possible, and confirmed by RTK GPS. Some areas throughout Removal Area 6A could not be excavated to the neat line. In these areas, the regulatory agencies were consulted to confirm that native riverbed material had been encountered. No additional excavations of near-shore material occurred. See Figure 4.5 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.12 Removal Area 6B

Vegetation was cleared from Removal Area 6B to provide access for construction activities in June 2007. Turbidity curtains were installed along the entire removal area in August 2007 to control resuspended sediments. Initial excavation of non-TSCA near-shore, bank, and floodplain sediments/soils was performed in September 2007. Excavated materials were stockpiled in Upland Area 6B1 until construction of Staging Area 3S was complete. The upland area was bermed to prevent water runoff outside of the material to be excavated.

Approximately 620 linear feet of bank and floodplain material was excavated to the neat line. Removal Area 6B was divided into 16 confirmation sampling grids (eight floodplain and eight bank). PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.4 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Excavation of near-shore materials was designed to be 30 feet off the southern river bank, however USEPA personnel determined by probing that the area beyond the as-built excavation limit had evidence that native riverbed materials (gravel and cobbles) were present. Consequently, the reach of the planned near-shore excavation was reduced in size from approximately 40 feet to approximately 20 feet. Because the size of the near-shore removal area was decreased, some planned excavation elevations were not applicable because they fell outside of the modified excavation area. Approximately 620 linear feet of near-shore material was removed during the initial excavation and confirmed by RTK GPS. See Figure 4.5 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

During the week of March 10, 2008, erosion of bank material was observed in Removal Areas 6B and 7; the likely cause was a high water event, caused by a combination of steady rainfall and melting snow, near the end of February 2008.

This erosion exposed a 6-inch thick lens of gray material within the 30-foot clean buffer zone in both removal areas. Additional excavations occurred at the direction of USEPA as described in Section 2.3.2.4. On July 23, 2008, USEPA submitted a letter titled *Removal Area 6B – Additional Excavation Needed in Grids 4, 5, and 6* (USEPA 2008b) to the KRSG directing the excavation of 2 to 12 inches of additional material from Grids 4, 5, and 6 of Removal Area 6B to remove potential PCB-containing sediments from the buffer zone. Approximately 350 cy of material was excavated from these areas under the supervision of USEPA and MDEQ on July 24, 2008. Following the excavation, both agencies verbally approved completion of removal activities in Removal Area 6B. No additional confirmation samples were collected. All three grids were brought back to grade with backfill and topsoil on July 25, 2008. The MDNR determined that the entire eroded bank in Removal Area 6B did not need to be rebuilt. Because the potential PCB-containing sediments had been removed, the river was allowed to create its own natural course in this area.

3.5.3.13 Upland Removal Area 6B1

Vegetation was cleared from Upland Area 6B1 in August 2007. Resuspended sediment controls were not necessary in the upland floodplain area. Excavation of non-TSCA floodplain soils was performed in October 2007. Excavated materials, including materials stockpiled during the excavation of Removal Area 6B, were transported to Staging Area 3S for processing and disposal. The berms and Visqueen liner from the stockpiling of the materials excavated from Removal Area 6B were also transported to Staging Area 3S for processing and disposal. Water was transported to Staging Area 3S via vacuum truck for treatment and disposal. Some excavated materials that were sufficiently dry and stable were directly loaded into trucks at Upland Removal Area 6B1 to be hauled offsite for disposal rather than at a staging area.

As stated in Section 3.5.3.12, some wet material excavated from Removal Area 6B was stockpiled in Upland Area 6B1. The dewatered sediment from Removal Area 6B and excavated soil from Upland Area 6B1 were loaded into trucks for offsite disposal.

Approximately 615 linear feet of floodplain material was excavated to the neat line. Upland Area 6B1 was divided into nine confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.4 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.14 Removal Area 7

Vegetation was cleared from Removal Area 7 to provide access for construction activities in August 2007. Turbidity curtains were installed along the entire removal area in October 2007 to control resuspended sediments. A flow deflector wall was installed at the upstream end of the removal area after the turbidity curtain due to high river velocities.

Initial excavation of non-TSCA near-shore, bank, and floodplain sediments/soils was performed between October and December 2007. Excavated materials were transported to Staging Area 3S for processing and disposal.

Approximately 445 linear feet of bank and floodplain material was excavated to the neat line during the initial excavation. Removal Area 7 was divided into 14 confirmation sampling grids (eight floodplain and six bank). PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg; consequently there was no additional excavation. See Figure 6.5 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 445 linear feet of near-shore material was removed to the neat line during the initial excavation and confirmed by RTK GPS. No problems were encountered during excavation, and no additional excavations of near-shore material occurred. See Figure 4.4 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

During the week of March 10, 2008, erosion of bank material was observed near Removal Areas 6B and 7. Approximately 15 feet of bank material was eroded along a 400 linear feet stretch of Removal Area 7. The upstream portion of the eroded bank material exposed an approximately 6-inch thick lens of gray material within the 30-foot clean buffer zone excavated in the floodplain area. The USEPA and MDEQ identified this material as potentially PCB-containing soil. The events that followed to remedy the erosion and exposure of potentially PCB-containing soil included:

- On April 11, 2008, ARCADIS submitted a proposal (ARCAIDS 2008g) to USEPA to revise the stabilization method for the eroded bank in Removal Area 7 with river run rock.

- On April 29, 2008, MDNR submitted a letter titled *Response to Erosion at Plainwell removal areas 6B and 7 (MDNR 2008)* to USEPA. USEPA submitted the letter to ARCADIS (USEPA 2008e), which instructed that minimal rock should be used to stabilize the eroded bank.

- On May 22, 2008, ARCADIS submitted a revised bank stabilization plan approach that utilized topsoil, river run rock, and coir logs for Removal Area 7 to the USEPA (ARCADIS 2008h). USEPA approved the plan on June 2, 2008 (USEPA 2008f).

- Approximately 100 cy of material from a gray lens of potentially PCB-containing material were excavated from Removal Area 7 on June 4, 2008 under the supervision of USEPA.

- The erosion protection system installation commenced on June 5, 2008 and continued throughout the week.

- Floodplain soil surrounding a utility pole in the area was also eroded during the storm event, exposing the utility pole to the edge of the river. Consumers Energy, the owner and operator of the utility pole, was contacted and relocated the pole 25 feet landward during the week of June 22, 2008, after restoration of the Removal Area 7 bank.

3.5.3.15 Removal Area 8

Vegetation was cleared from Removal Area 8 to provide access for construction activities in August 2007. Turbidity curtains were installed along the entire removal area in November 2007 to control resuspended sediments. Excavation of non-TSCA floodplain and near-shore sediments/soils was performed between November and December 2007. Excavated materials were transported to Staging Area 3S for processing and disposal.

Approximately 470 linear feet of floodplain material was excavated to the neat line. Removal Area 8 was divided into six confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.5 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 505 linear feet of near-shore material was removed to the neat line and confirmed by RTK GPS. No problems were encountered during excavation, and no additional excavations of near-shore material occurred. See Figure 4.4 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.3.16 Island Removal Areas

Sediment/soil materials from three islands (one located upstream of the US 131 Bridge (Island 3) and two located downstream of the bridge (Islands 1 and 2) were removed as part of the TCRA.

Vegetation was cleared from Island 3 to provide access for construction activities in June 2007. Turbidity curtains were installed along the entire island in June 2007 to control resuspended sediments.

Vegetation removal did not occur at Islands 1 and 2 because large vegetation was not present and any grasses were removed during excavation activities. Each island was completely enclosed in turbidity curtain in September 2007. A temporary land bridge was constructed from the northern side of the river so that equipment and personnel could access the island areas.

Sediment from Islands 1 and 2 was excavated in September 2007. Excavation of floodplain soils from Island 3 was performed between July and August 2007. Non-TSCA material was excavated from all three islands. The excavation activities for the islands are described below.

- Island 1 - Approximately 115 linear feet (from Stations 44+30 to 45+45) of sediment was removed to the native riverbed, approved by USEPA, and confirmed by RTK GPS. No problems were encountered during excavation, and removal was determined to be complete.

- Island 2 - Approximately 245 linear feet (from Stations 46+50 to 48+95) of sediment were removed to the native riverbed, approved by USEPA, and confirmed by RTK GPS. No problems were encountered during excavation, and removal was determined to be complete.

- Island 3 – The nature of the soil materials in Island 3 had not been established in the Design Report, but was evaluated prior to excavation activities. Investigations of the soil materials on Island 3 suggested that they did not consist of deposited river sediments, but instead were spoil material generated as a result of the construction of the US 131 Bridge. As such, the soil material from Island 3 was excavated and sampled according to the floodplain soil protocol.

  Approximately 102 linear feet (from Stations 50+40 to 52+05) of floodplain material was excavated to the neat line. Excavated material was transported to Staging Area 1N for processing and disposal. The area was divided into four confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.3 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

3.5.3.17 Cofferdam Removal Area 1

Vegetation was cleared from Cofferdam Removal Area 1 to provide access for construction activities in July 2007. This area was enclosed by the Phase 1 Cofferdam, so no additional turbidity controls were required. Approximately 150 linear feet of material located in Removal Area 13B was located within the Phase 1 Cofferdam. This material was excavated as a part of Phase 1 Cofferdam activities. See Section 3.5.4.10 or additional information.

Sediment excavation inside the Phase 1 and Phase 2 cofferdams was designed to be performed “in the dry,” which required dewatering for each area prior to excavation. This was accomplished by a series of pumps installed within the cofferdam areas after the installation of the sheet pile wall for either of the cofferdam structures.

The decanted water was directly discharged downstream and the turbidity level in the decanted water (measured at the dewatering pump discharge) and immediately upstream of the cofferdam was monitored throughout dewatering activities. A water treatment system was installed to treat the decant water in the event that the downstream turbidity level exceeded two times (2x) the upstream turbidity level.

A pump capable of pumping up to 500 gallons per minute (gpm) was installed to dewater Cofferdam Area 1 on October 3, 2007 and water was discharged downstream of the cofferdam. Downstream turbidity levels exceeded twice the upstream level, so the flow rate of the pump was decreased. However, the turbidity exceedance was not remedied.

It was determined that the pump was too large to dewater the area without causing turbidity exceedances. As a result, a sump was installed to dewater the cofferdam area. However, the stable water level in the area suggested that the recharge rate in Cofferdam Area 1 might exceed the ability to effectively dewater the area. In addition, downstream turbidity readings continued to exceed two times the upstream readings. As a result, the removed water was pumped to a treatment system. See Section 3.6.2.2 for additional information on construction dewatering water treatment.

Excavation of non-TSCA mid-channel, near-shore, bank, and floodplain sediments/soils was performed between October 2007 and January 2008. Excavated material was transported to Staging Area 5S for processing and disposal.

Approximately 450 linear feet of floodplain and bank material was removed. Cofferdam Area 1 was divided into six confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.10 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Mid-channel sediment was removed behind the Phase 1 Cofferdam as necessary to regrade the western channel. Excavation was performed to the neat line and confirmed by RTK GPS. The 175-foot long former Plainwell Dam powerhouse structure was removed using an excavator equipped with hydraulic hammers to an elevation of 696.5 NAVD 88, as confirmed by RTK GPS. The former powerhouse structure was generally removed from west to east. An earthen berm was installed downstream of the former powerhouse structure to provide equipment access. This berm was removed at the conclusion of removal activities. The embankment between the former spillway and the former powerhouse was regraded as necessary to support the installation of erosion control and restoration materials.

Construction debris from the former powerhouse structure was disposed of at the offsite landfill along with stabilized soil and sediment. Three vertical shaft turbines from the former powerhouse were removed, decontaminated, and donated to the City of Plainwell. No problems were encountered during excavation, and removal was determined to be complete. See Figure 4.1 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4 Phase 2

Phase 2 construction activities were performed between March 2008 and June 2009 included sediment/soil removal at Removal Areas 9A to 13B; Mid-Channel Removal Areas A to C; and Cofferdam Area 2; installation and removal of the Phase 2 Cofferdam; and operation and removal of the WCS. Approximately 17,850 cy of TSCA and 69,825 cy of non-TSCA material were disposed of at licensed offsite commercial landfills. Generally, excavation occurred upstream to downstream; exceptions to that sequencing are noted below in the sections summarizing removal activities in each area.

3.5.4.1 Removal Area 9A

Vegetation was cleared from Removal Area 9A to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in April 2008 to control resuspended sediments. Excavation of non-TSCA near-shore, bank, and floodplain sediments/soils was performed between April and May 2008. Excavated materials were transported to Staging Area 4N for processing and disposal.

Approximately 535 linear feet of floodplain and bank material was removed. During excavation on April 30, 2008, gray material was observed below the design elevation in the upstream portion of Removal Area 9A. The extent of the material was delineated and additional excavation based on visual observations occurred on May 2, 2008. This material was removed before confirmation sampling was performed.

Removal Area 9A was divided into 16 (eight floodplain and eight bank) confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.6 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 530 linear feet of near-shore material was excavated to the neat line (except as noted below) and confirmed by RTK GPS. Sediment in Removal Area 9A near Grids 3 and 4 could not be excavated to the neat line. The USEPA was consulted to confirm that native riverbed material had been encountered. No additional excavations of near-shore material occurred. See Figures 4.3 and 4.4 for sediment excavation as-built figures and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.2 Removal Area 9B

Vegetation was cleared from Removal Area 9B to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in April 2008 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore, bank, and floodplain sediments/soils was performed in April 2008. Excavated materials were transported to Staging Area 3S for processing and disposal.

Approximately 500 linear feet of floodplain and bank material was removed. Removal Area 9B was divided into 16 (eight floodplain and eight bank) confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.6 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 510 linear feet of near-shore material was removed to the neat line (except as noted below) and confirmed by RTK GPS. Sediment in Removal Area 9B near Grids 5 and 7 could not be excavated to the neat line. USEPA was consulted to confirm that native riverbed material had been encountered. No additional excavations of near-shore material occurred. See Figure 4.4 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.3 Removal Area 10A

Vegetation was cleared from Removal Area 10A to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in April 2008 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore, bank, and floodplain sediments/soils was performed in May 2008. Excavated materials were transported to Staging Area 4N for processing and disposal.

Approximately 500 linear feet of floodplain and bank material was removed. Removal Area 10A was divided into 12 (eight floodplain and four bank) confirmation sampling grids. Evidence (gravel and cobbles) of the pre-impoundment river bed was observed during excavation activities in bank sample grids 2 through 5. USEPA representatives concluded that no confirmation sampling would be necessary in these areas. PCB concentrations in the confirmation samples that were collected did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.7 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 215 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS. No problems were encountered during excavation, and removal was determined to be complete. See Figure 4.3 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.4 Removal Area 10B and Upland Area 10B1

Removal Area 10B and Upland Area 10B1 were excavated together. Vegetation was cleared from the areas to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in April 2008 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore, bank, and floodplain sediments/soils was performed between April and June 2008. The majority of excavated materials were transported to Staging Area 3S for processing and disposal. Some wet material excavated from Removal Area 10B was stockpiled in Upland Area 10B1 and allowed to dewater. The area was bermed to contain water. The dewatered sediment from Removal Area 10B and excavated soil from Upland Area 10B1 were loaded into trucks for offsite disposal.

Approximately 800 linear feet of bank material and 490 linear feet of upland floodplain material were removed. Removal Area 10B and Upland Area 10B1 was divided into 36 (28 floodplain and eight bank) confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.7 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Bank material could not be excavated from the downstream section of Removal Area 10B, between stations 20+80 to 22+20, at Grids 9-BS and 10-BS. Material in this area was included in an underground utility line buffer zone. Only visible material was excavated in this area. Refer to Section 2.3.4 for additional information about the utility line buffer zone.

Approximately 600 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS. No problems were encountered during excavation, and no additional excavations of near-shore material occurred. Near-shore sediment was not excavated between stations 20+00 to 21+60 because material in this location was included in an underground utility line buffer zone. As described in Section 2.3.4, a 30-foot exclusion zone was established around the pipelines, and only visible sediments above the water line in this zone were removed. See Figure 4.3 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.5 Removal Area 11A and Upland Area 11A1

Vegetation was cleared from Removal Area 11A and Upland Area 11A1 to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area (with the exception of the areas included in the utility line buffer zone) was installed in May 2008 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore, bank, and floodplain sediments/soils was performed between May and August 2008 and in January 2009. Excavated materials were transported to Staging Area 4N for processing and disposal.

Approximately 605 linear feet of floodplain material in Removal Area 11A and 465 linear feet of bank material were excavated to the neat line. Removal Area 11A was divided into twenty-seven (20 floodplain and 7 bank) confirmation sampling grids. Laboratory data confirmed that PCB concentrations in six (Grids 5 TSCA; 5 BS; 6A TSCA; 6B TSCA; 6 BS; and 8BS) grids exceeded the PCB performance standard of 5 mg/kg. The additional excavation activities are described below. PCB concentrations in the confirmation samples for all other grids did not exceed the PCB performance standard of 5 mg/kg.

A PCB concentration of 11 mg/kg was detected in soil sample TS20128, collected from Removal Area 11A, Grid 5 (TSCA) on July 11, 2008. An additional 6 inches of material was excavated on July 18, 2008, and the area was resampled (TS20134) on July 21, 2008. A PCB concentration of 9.5 mg/kg was detected in the second sample, so an additional 6 inches of material was removed on July 24, 2008. The area was resampled (TS20135) on July 24, 2008. A PCB concentration of 14 mg/kg was detected in the third sample collected from the area. An additional 6 inches of material was excavated during the week of August 4 and the area was resampled (TS20144) on August 6, 2008. A PCB concentration of 0.58 mg/kg was detected in this sample, so removal was determined to be complete.

A PCB concentration of 17 mg/kg was detected in soil sample TS20117 collected from Removal Area 11A, Grid 5BS on July 9, 2008. An additional 6 inches of material was excavated, and the area was resampled on July 11, 2008 (TS20126). A PCB concentration of 2.8 mg/kg was detected in the second sample, so removal was determined to be complete.

PCB concentrations of 7.6 and 7.2 mg/kg were detected in soil sample TS20129 and its duplicate TS20130, collected from Removal Area 11A, Grid 6BS on July 16, 2008. An additional 6 inches of material was excavated on July 18, 2008, and the area was resampled on July 21, 2008 (TS20133). A PCB concentration of 15 mg/kg was detected in the second sample collected from this area. An additional 6 inches of material was excavated during the week of August 4, 2008 and the area was resampled (TS20146) on August 7, 2008. A PCB concentration of 16 mg/kg was detected in this sample, so an additional 6 inches of material was excavated and the area was resampled (TS20154) on August 15, 2008. USEPA also collected a split of this sample (APS-081508-36-SD/TS20154). A PCB concentration of 3.3 mg/kg was detected in both samples, so removal was determined to be complete.

A PCB concentration of 5.4 mg/kg was detected in sample TS20178, collected from Removal Area 11A, Grid 6A (TSCA) on August 21, 2008. Because approximately 18 inches of additional material had to be excavated from Removal Area 11A, Grid 5 (TSCA) before a PCB concentration less than 5 mg/kg was detected, ARCADIS decided to excavate an additional 18 inches of material from Grid 6A (TSCA), rather than excavate and resample in 6-inch intervals. The material was excavated and the area was resampled on August 26, 2008 (TS20193). PCBs were not detected in the sample (<0.33 mg/kg), so removal was determined to be complete.

A PCB concentration of 11 mg/kg was detected in sample TS20179, collected from Removal Area 11A, Grid 6B (TSCA) on August 21, 2008. Because approximately 18 inches of additional material had to be excavated from Removal Area 11A, Grid 5 (TSCA) before a PCB concentration less than 5 mg/kg was detected, ARCADIS decided to excavate an additional 18 inches of material from Grid 6B TSCA, rather than excavate and resample in 6-inch intervals. The material was excavated and the area was resampled on August 26, 2008 (TS20194). PCBs were not detected in the sample (<0.33 mg/kg), so removal was determined to be complete.

A PCB concentration of 13 mg/kg was detected in soil sample TS20141, collected from Removal Area 11A, Grid 8BS on July 31, 2008. An additional 6 inches of material was excavated during the week of August 4, 2008 and the area was resampled (TS20145) on August 7, 2008. A PCB concentration of 13 mg/kg was detected in this sample, so an additional 6 inches of material was excavated and the area was resampled (TS20155) on August 15, 2008. A PCB concentration of 1.6 mg/kg was detected in the sample, so removal was determined to be complete. See Figure 6.8 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Bank material could not be excavated between stations 20+80 to 22+20. As described in Section 2.3.4, a 30-foot exclusion zone was established around the underground utility pipelines in this area, and only visible soils above the water line in this zone were removed. Refer to Section 2.3.4 for additional information about the utility line buffer zone.

As water levels dropped in the winter of 2009, bank material targeted for removal became exposed. On January 13, 2009, the exposed bank material was removed under the supervision of MDEQ. MDEQ verbally determined that excavation was complete and no confirmation sampling was necessary.

As established in Section 3.5.2.4, some floodplain areas were over-excavated to include material with PCB concentrations believed to be less than 4 mg/kg. This material was sampled for potential reuse as cover material to enhance the riparian habitat in upland areas located outside the scope of the TCRA. A composite sample (TS10000) was collected according to the sampling protocol described in Section 3.2.3 on August 13, 2008 from the potentially reusable soil stockpiled from Removal Area 11A. Analytical results showed a PCB concentration of 3.6 mg/kg and a lead concentration of 424 mg/kg in the sample. These results were compared to the applicable Part 201 cleanup criteria and Part 213 Risk Based Screening Levels (RBSLs) provided in Operational Memorandum No. 1 (Table 2, Column #19, Direct Contact Criteria & RBSLs), issued by the RRD of MDEQ on January 23, 2006. According to the TCRA Design Report, material with a PCB concentration between 1 mg/kg and 4 mg/kg can only be used as backfill in priority areas that are outside the post-removal 100-year floodplain. However, the lead concentration exceeded the Direct Contact Criterion RBSL of 400 mg/kg. As such, the stockpiled material was transported offsite for disposal, and not used for cover material. See Table 6 for soil reuse sampling results. Laboratory analytical data are included in Appendix C-5.

Approximately 480 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS. Excavation of the near-shore sediments between stations 20+80 to 22+20 could not be performed. As described in Section 2.3.4, a 30-foot exclusion zone was established around the underground utility pipelines in this area, and only visible soil and sediments above the water line in this zone were removed. Refer to Section 2.3.4 for additional information about the utility line buffer zone. See Figure 4.2 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.6 Removal Area 11B

The original scope of the TCRA did not include removal of material identified as Area 11B. This section of the former Plainwell Impoundment was located between stations 16+75 and 20+00. On May 12, 2008, the KRSG received written direction from USEPA that near-shore, bank, and floodplain excavation of the area was to be completed, as described in Section 2.3.2.3.

Vegetation was cleared from Removal Area 11B to provide access for construction activities in May 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area was installed in May 2008 to control resuspended sediments. Excavation of non-TSCA near-shore, bank, and floodplain sediments/soils was performed between May and July 2008. Excavated materials were transported to Staging Area 5S for processing and disposal.

Approximately 325 linear feet of floodplain and bank material was removed. Removal Area 11B was divided into ten (five floodplain and five bank) confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.8 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 340 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS. Sediment in Removal Area 11B near Grid 5 could not be excavated to the neat line. The USEPA was consulted to confirm that native riverbed material had been encountered. No additional excavations of near-shore material occurred. See Figure 4.2 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.7 Removal Area 12A and Upland Area 12A1

Vegetation was cleared from Removal Area 12A and Upland Area 12A1 to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in July 2008 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore, bank, and floodplain sediments/soils from Removal Area 12A and Upland Area 12A1 was performed between August and September 2008. The majority of excavated materials were transported to Staging Area 4N for processing and disposal. Some wet material excavated from Removal Area 12A was stockpiled in Upland Area 12A1 and allowed to dewater. The area was bermed to contain water. The dewatered sediment from Removal Area 12A and excavated soil from Upland Area 12A1 were loaded into trucks for offsite disposal.

Approximately 580 linear feet of floodplain and bank material was removed from Removal Area 12A and approximately 195 linear feet of floodplain soil was removed from Upland Area 12A1. Removal Area 12A and Upland Area 12A1 were sampled at the same time and were divided into 47 (39 floodplain and 8 bank) confirmation sampling grids. With the exception of Grids 6D (TSCA) and 6BS, PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. See Figure 6.9 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

A PCB concentration of 4.2 mg/kg was detected in soil sample TS20142 collected from Removal Area 12A, Grid 6BS on August 6, 2008. However, a PCB concentration of 5.9 mg/kg was detected in USEPA split sample APS-080608-34-SD/TS20142, which was collected from the same grid. In response to the USEPA split sample results, an additional 6 inches of material was excavated during the week of August 4, 2008 and the area was resampled (TS20147) on August 11, 2008. A PCB concentration of 1 mg/kg was detected in this sample, so removal was determined to be complete.

A PCB concentration of 6.9 mg/kg was detected in sample TS20170 collected from Removal Area 12A, Grid 6D (TSCA) on August 20, 2008. An additional 6 inches of material was excavated from the area on August 22, 2008, and the area was resampled (TS20180) on August 25. A PCB concentration of 2.9 mg/kg was detected in the sample, so removal was determined to be complete.

Approximately 620 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS in Removal Area 12A. No problems were encountered during excavation, and removal was determined to be complete. See Figure 4.2 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

A composite sample (TS10001) was collected according to the sampling protocol described in Section 3.2.3 on September 4, 2008 from the potentially reusable soil that was over-excavated and stockpiled from Removal Area 12A. Sample TS10001 was collected under the supervision of MDEQ and USEPA and biased towards suspect gray material. A PCB concentration of 16.9

mg/kg and a lead concentration of 834 mg/kg were detected in the sample. Sample TS10004 was collected on September 10, 2008 from nine random locations within the same soil pile and submitted for PCB analysis to compare the PCB data from the two samples. A PCB concentration of 3.2 mg/kg was detected in soil sample TS10004. These results were compared to the applicable Part 201 cleanup criteria and Part 213 RBSLs provided in Operational Memorandum No. 1 (Table 2, Column #19, Direct Contact Criteria & RBSLs), issued by the MDEQ RRD on January 23, 2006. According to the TCRA Design Report, material with a PCB concentration between 1 mg/kg and 4 mg/kg was only to be used as backfill in priority areas that are outside the post-removal 100-year floodplain. None of these priority areas are located outside of the 100-year floodplain. In addition, the lead concentration exceeded the Direct Contact Criterion RBSL of 400 mg/kg. As such, the stockpiled material was transported offsite for disposal, and not used for cover material. See Table 6 for soil reuse sampling results. Laboratory analytical data are included in Appendix C-5.

3.5.4.8 Removal Area 12B

Vegetation was cleared from Removal Area 12B to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in July 2008 to control resuspended sediments. Excavation of non-TSCA near-shore, bank, and floodplain sediments/soils was performed between June and July 2008. Excavated materials were transported to Staging Area 5S for processing and disposal.

Approximately 595 linear feet of floodplain and bank material was removed. During excavation, potential PCB-containing material was observed downstream of the downstream limit of Removal Area 12B established in the Design Report. ARCADIS decided to remove this material. The downstream boundary of Removal Area 12B was extended approximately 45 feet to excavate this material.

Removal Area 12B was divided into 17 (nine floodplain and eight bank) confirmation sampling grids. PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. As such, removal was determined to be complete. See Figure 6.9 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

Approximately 595 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS. Sediment in Removal Area 12B near Grid 9 could not be excavated to the neat line. The USEPA was consulted to confirm that native riverbed material had been encountered. No additional excavations of near-shore material occurred. See Figure 4.2 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.9 Removal Area 13A and Upland Area 13A1

Vegetation was cleared from Removal Area 13A to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in July 2008 to control resuspended sediments. Excavation of TSCA and non-TSCA near-shore, bank, and floodplain sediments/soils from Removal Area 13A and Upland Area 13A1 was performed between May 2008 and January 2009. The majority of excavated materials were transported to Staging Area 4N for processing and disposal. Some wet material excavated from Removal Area 13A was stockpiled in Upland Area 13A1 and allowed to dewater. The area was bermed to contain water. The dewatered sediment from Removal Area 13A and excavated soil from Upland Area 13A1 were loaded into trucks for offsite disposal.

Approximately 855 linear feet of floodplain and bank material was removed from Removal Area 13A. Upland Area 13A1 consisted of approximately 355 linear feet of floodplain soil. Removal Area 13A and Upland Area 13A1 were divided into 43 (33 floodplain and 10 bank) confirmation sampling grids. With the exception of Grids 8 TSCA and 9A TSCA, PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. See Figure 6.10 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

A PCB concentration of 7.0 mg/kg was detected in soil sample TS20271, collected from Removal Area 13A, Grid 8 TSCA on January 13, 2009. An additional 6 inches of material was excavated, and the grid was resampled (TS20272) on January 15, 2009. A PCB concentration of < 0.33 mg/kg was detected in sample TS20272, so excavation was determined to be complete.

A PCB concentration of 8.8 mg/kg was detected in soil sample TS20258, collected from Removal Area 13A, Grid 9A TSCA on December 30, 2008. An additional 6 inches of material was excavated, and the grid was resampled (TS20260) on January 5, 2009. A PCB concentration of 2.7 mg/kg was detected in sample TS20260, so excavation was determined to be complete.

A composite sample (TS10005) was collected according to the sampling protocol described in Section 3.2.3 on October 29, 2008 from the potentially reusable soil over-excavated and stockpiled from Removal Area 13A. A lead concentration of 1,090 mg/kg was detected in the sample. The analytical results were compared to the applicable Part 201 cleanup criteria and

Part 213 RBSLs provided in Operational Memorandum No. 1 (Table 2, Column #19, Direct Contact Criteria & RBSLs), issued by the MDEQ RRD on January 23, 2006. The lead concentration exceeded the Direct Contact Criterion RBSL of 400 mg/kg. As such, the stockpiled material was transported offsite for disposal, and not used for cover material. See Table 6 for soil reuse sampling results. Laboratory analytical data are included in Appendix C-5.

Approximately 855 linear feet of near-shore material was excavated to the neat line and confirmed by RTK GPS. The majority of excavated materials were transported to Staging Area 4N for processing and disposal. Some wet material excavated from Removal Area 13A was stockpiled in Upland Area 13A1 and allowed to dewater. The area was bermed to contain water. The dewatered sediment from Removal Area 13A and excavated soil from Upland Area 13A1 were loaded into trucks for offsite disposal.

No problems were encountered during excavation, and removal was determined to be complete. See Figure 4.1 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.10 Removal Area 13B

Vegetation was cleared from Removal Area 13B to provide access for construction activities in February 2008. A combination of a flow deflector wall at the upstream portion of the removal area and turbidity curtains along the entire removal area were installed in July 2008 to control resuspended sediments. Excavated material was transported to Staging Area 5S for processing and disposal at an offsite landfill.

Approximately 150 linear feet of material at the downstream end of Removal Area 13B, adjacent to the Phase 1 Cofferdam Area, was excavated in January 2008 along with sediments from Cofferdam Area 1. The area was excavated at that time to allow for installation of erosion protection associated with the WCS. The area was divided into two grids (Grids 8 and 9) that were sampled at that time. The rest of the near-shore and floodplain sediments/soils in Removal Area 13B were excavated and sampled between March and October 2008.

Approximately 640 linear feet of floodplain and bank material was removed in total. Removal Area 13B was divided into 24 (14 floodplain and 10 bank) confirmation sampling grids. With the exception of Grid 7 TSCA, PCB concentrations in the confirmation samples did not exceed the PCB performance standard of 5 mg/kg. See Figure 6.10 and Table 5 for confirmation sampling grid locations and results. Laboratory analytical data are included in Appendix C-4.

A PCB concentration of 12 mg/kg was detected in soil sample TS20219, collected from Removal Area 13B, Grid 7 TSCA on October 10, 2008. An additional 6 inches of material was excavated and sample TS20230 was collected on October 14, 2008. A PCB concentration of 0.56 mg/kg was detected in the sample and removal was determined to be complete.

Approximately 640 linear feet of near-shore material was excavated and confirmed by RTK GPS. Sediment in Removal Area 13B near Grid 8 could not be excavated to the neat line. The USEPA was consulted to confirm that native riverbed material had been encountered. No additional excavations of near-shore material occurred. See Figure 4.1 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.4.11 Mid-Channel Area A

No vegetation removal was necessary for mid-channel material removal activities. Steel sheeting was used to isolate the area during removal and control resuspended sediments. The excavator was loaded onto a barge as necessary to perform mid-channel area excavation. Excavation of TSCA and non-TSCA sediments was performed in October 2008. Excavated material was transported to Staging Area 4N or 5S for processing and disposal at an offsite landfill.

Sediment was removed between stations 5+30 and 7+50. The mid-channel area consisted of sediments located between the outer edges of near-shore removal of Removal Area 13A on both sides of the river.

Excavation of Mid-Channel Area A was completed in two different parts. A steel sheet pile wall was driven through the middle of the area, from the upstream to downstream boundaries. The southern section ("B" side) of Mid-Channel Area A was then enclosed and incorporated in the removal of Removal Area 13B near-shore and bank removal activities. The northern section ("A" side) of Mid-Channel Area A was enclosed and incorporated in the removal of Removal Area 13A near-shore and bank removal activities. Mid-Channel Area A was excavated to the neat line and confirmed by RTK GPS. No additional excavations of mid-channel material occurred. See Figure 4.1 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

During removal of the southern section of Mid-Channel Area A, a storm occurred as described in Section 3.11. During and following the storm event, water spilled into the southern section of Mid-channel A that was enclosed with sheet pile. When the river levels decreased, water levels enclosed in the sheet pile were also allowed to decrease before excavation was resumed.

3.5.4.12 Mid-Channel Area B

No vegetation removal was necessary for mid-channel material removal activities. Steel sheeting was used to isolate the area during removal and control resuspended sediments. The excavator was loaded onto a barge as necessary to perform mid-channel area excavation. Excavation of non-TSCA sediment in Mid-Channel Area B was performed between July and August 2008. Excavated material was transported to Staging Area 4N for processing and disposal at an offsite landfill.

Mid-channel material was removed between stations 8+80 and 11+30, from the outer edge of the near-shore removal (Removal Area 12A) on the northern side (“A” side) of the river to 40 feet from the existing top-of-bank on the southern side of the river. Excavation of Mid-Channel Area B was incorporated in the removal of Area 12A near-shore and bank removal activities. Mid-Channel Area B was excavated to the neat line and confirmed by RTK GPS. No additional excavations of mid-channel material occurred. See Figure 4.2 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

On July 31, 2008, turbidity levels downstream of the Mid-Channel Area B exceeded twice the upstream turbidity reading during excavation activities. A deflector wall was installed along the upstream (eastern) and southern sides of the mid-channel area, and a turbidity curtain was installed along the downstream side of the removal area. The upstream and downstream resuspended sediment controls extended from the southern side of Mid-Channel Area B to the northern bank of the river.

Excavation activities began at 0730 on July 31, 2008 and turbidity readings were collected as required throughout the day. At 1500, an upstream turbidity reading of 1.5 NTU and a downstream turbidity reading of 15.4 NTU were recorded. During inspection of the turbidity curtain, a visible silt plume was identified downstream of Mid-Channel Area B. Work was suspended for the remainder of the day while the turbidity curtain was inspected and repaired as required.

Excavation activities resumed at 0730 on August 1, 2008; at 0900 an upstream turbidity reading of 1.0 NTU and a downstream turbidity level of 4.0 NTU were recorded. Removal activities in this area were suspended for the remainder of the day. Steel sheeting was installed on the downstream end of Mid-Channel Area B to completely enclose the work area before resuming excavation activities on August 2, 2008. No elevated turbidity levels were recorded during the remainder of excavation activities in Mid-Channel Area B. Turbidity monitoring logs and calibration logs are included in Appendix F.

3.5.4.13 Mid-Channel Area C

No vegetation removal was necessary for mid-channel material removal activities. Steel sheeting was used to isolate the area during removal and control resuspended sediments. The excavator was loaded onto a barge as necessary to perform mid-channel area excavation. Excavation of non-TSCA and TSCA sediment in Mid-Channel Area C was performed in May 2008. Excavated material was transported to Staging Area 4N for processing and disposal at an offsite landfill.

Mid-channel material was removed between stations 22+00 to 23+00, from the outer edge of near-shore removal on the northern side (“A” side) of the river to a line that encompassed a discrete area in which sample locations were found to contain PCB concentrations greater than 50 mg/kg. Excavation of Mid-Channel Area C was incorporated in the removal of Area 10A near-shore and bank removal activities. Mid-Channel Area C was excavated to the neat line and confirmed by RTK GPS. See Figure 4.3 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

Mid-channel materials were not excavated between stations 20+70 and 22+00. As described in Section 2.3.4, a 30-foot exclusion zone was established around the underground utility pipelines in this area, and only visible sediments above the water line in this zone were removed. Refer to Section 2.3.4 for additional information about the utility line exclusion zone.

3.5.4.14 Cofferdam Area 2

Vegetation was cleared from Cofferdam Area 2 to provide access for construction activities in February 2008. The Phase 2 Cofferdam provided control of resuspended sediments. Excavation of non-TSCA sediments was performed between September and December 2008. Excavated material was transported to Staging Area 4N for processing and disposal at an offsite landfill.

Mid-channel material was removed between stations 0+55 to 1+00 and from upstream of the former Plainwell spillway to the Phase 2 Cofferdam. Excavation of Cofferdam Area 2 was incorporated in the removal of some of Removal Area 13A near-shore and bank removal activities. Cofferdam Area 2 was excavated to the neat line and confirmed by RTK GPS. See Figure 4.1 for a sediment excavation as-built figure and Appendix J for RTK GPS excavation confirmation depths.

3.5.5 WCS Operation

The WCS was designed for passive operation, which means that the water level upstream of the structure was controlled by the crest elevation of the stop logs. When the top level of stop logs was removed, the water level gradually fell as the water flowed over the next level of stop logs. Stop logs across the central portion of the structure were placed or removed in a controlled manner so as to maintain control of water levels, to the extent practicable, at all times during construction. Except in the case of an emergency, water levels at the WCS were lowered through stop log removal at a maximum rate of 6 inches per day, or one row of logs per day. During September 2008, more than one row of stop logs was removed in one day due to rapidly rising water levels. See Section 3.11 for additional information regarding the September 2008 storm event.

When lower (600 cubic feet per second [cfs]) and median (1,100 cfs) flow conditions occurred during the removal action, the WCS was used to control the water surface elevation at the downstream end of the former Plainwell Impoundment. During higher flow events (up to 2,000 cfs), stop logs were added to raise the water surface elevation to minimize erosion. For flows above 2,000 cfs, stop logs were added to match the water levels in the river (see the Design Report, Section 2.4.1). The United States Geologic Survey (USGS) real-time stream gage in Comstock (USGS Gage No. 04106000) was used to monitor flow in the Kalamazoo River upstream of the former Plainwell Impoundment and to identify when higher flows were occurring, prior to reaching the project area. This gage was located far enough upstream of the former Plainwell Impoundment that there was sufficient time to add stop logs to the WCS before the peak flows occurred in the construction area. The process and guidelines for operating the WCS are described in the *WCS Operations Plan (ARCADIS 2008i)*. Vegetative debris that accumulated was removed from the WCS as needed to prevent blockage throughout WCS operation.

Removal of the Phase 1 Cofferdam began during the week of April 28, 2008. At that time, flow from the Kalamazoo River first contacted the WCS. However the WCS was not regulating water level at this time – because the river still freely flowed over the original dam spillway, it acted as a temporary cofferdam. Removal of the Phase 1 Cofferdam continued throughout May 2008. On May 15, 2008, six rows of stop logs were removed from each bay of the WCS, setting the elevation of the stop logs equal to that of the river. Three more rows of stop logs were removed during the week of May 19, 2008. At that time, the WCS began regulating water levels. Stop logs were removed one row at a time until the week of June 1, 2008. By that point, fifteen rows of stop logs had been removed, lowering the water elevation to 703.15 feet NGVD 29. The WCS remained at this elevation until the week of July 21, 2008.

The Phase 2 Cofferdam was installed between the weeks of July 21 and August 11, 2008, effectively directing all of the flow of the Kalamazoo River through the Western Channel and over the WCS. During installation of the cofferdam, stop logs were added to raise the water level to allow sheet pile installation equipment and barges to navigate the water further upstream. After the sheet pile was driven, the water level was once again lowered to 703.15 feet NGVD 29. During the week of September 15, 2008 there was a significant storm event, and emergency procedures, including stop log removal and placement of additional erosion protection, were carried out. These responses are discussed in more detail in Section 3.11. The stop log elevation was 700.45 feet until the week of October 6, 2008, when it was raised to 701.80 feet. Details of the WCS operation are included in Appendix L.

While the WCS was operating, scour monitoring was conducted in the Mid-Channel Areas A and B upstream of the WCS to ensure that sediment targeted for excavation did not erode before it could be removed.

Mid-Channel Area C was excavated before WCS operation began. For the two remaining mid-channel removal areas, two rows of three galvanized steel fence posts were installed in each area in May 2009. Depth to sediment was measured using a PVC sleeve with a 1 square foot leveling plate at the end. Sediment bed elevation was calculated based on the water surface elevation at the time of the depth measurement. Buffalo Industrial Diving Company performed an initial assessment of Mid-Channel Areas A and B on May 7, 2008. Divers documented existing river bottom conditions near and around the scour monitoring locations including river bottom elevations and sediment conditions. Baseline sediment elevation measurements were collected on May 16, 2008 prior to operating the WCS. Scour monitoring was then collected on a weekly basis or after a significant storm event. Scour monitoring was discontinued during the weeks of September 15 and 22, 2008 due to unsafe flow conditions in the water. Removal of Mid-Channel Area A commenced during the week of September 29, 2008, and scour monitoring in that area was discontinued. The WCS continued to operate through October 2008. Scour monitoring data was submitted to USEPA in a letter titled *Plainwell TCRA Scour Monitoring 081409* (ARCADIS 2008j). Scour monitoring did not show any areas of significant loss or deposition of material. However, precise calculation of scour or deposition was not possible due to difficulties in maintaining control of the monitoring posts. Scour monitoring logs are included in Appendix M.

3.6 Soil Dewatering, Processing, and Water Treatment

Two types of sediment/soil dewatering technologies were employed during the TCRA to decrease the water content of the excavated material before it was transported offsite for disposal. “Sediment/soil drainage” involved removing water from excavated sediments or soils so they could be safely and efficiently transported for disposal. “Construction dewatering” focused on the drawdown of river water levels within the cofferdams to decrease the amount of water that was entrained in sediments prior to excavation and was described in Section 3.4.1.

3.6.1 Sediment/Soil Drainage and Stabilization

Sediments and soils excavated below the water table required dewatering before transportation to disposal facilities. Drainage and stabilization methods used throughout the project included gravity drainage, dry soil mixing, and the addition of solidification agents.

Wet soils and sediments that were not drained in the floodplain areas were mobilized to staging areas for processing. Five staging areas were constructed as described in Section 3.2.4.2 to process and prepare soils and sediments for transportation and offsite disposal. Drainage water generated at staging areas was collected and treated as described in Section 3.6.2.

3.6.1.1 Dry Soil Mixing

When possible, dry soil targeted for offsite disposal was used as a solidification agent. During soil and sediment processing at the staging areas, dry and wet piles were often mixed using excavators and dozers. The addition of dry soils and gravity dewatering eliminated most free liquids in the excavated materials, but at times a solidification agent was used for very wet or fine grained materials that could not be dewatered using gravity drainage or dry soil mixing. The mixture of dry and wet soils was restricted to blending only those materials categorized as requiring TSCA or non-TSCA disposal with like materials- at no time were TSCA materials blended with non-TSCA materials.

3.6.1.2 Solidification Agents

Portland cement and cement kiln dust were used as solidification agents. Wet material was loaded onto a conveyor belt with an excavator or loader and fed to the pug mill that was located in each staging area, where it mixed with the solidification agent. The final processed material contained approximately 90% targeted material and 10% solidification reagent. This processed material was then suitable for transportation and disposal at an offsite landfill.

3.6.1.3 Gravity Drainage

Water generated during gravity drainage efforts in floodplain areas targeted for removal was not collected for treatment. The drainage areas were protected with earthen berms to mitigate the potential for migration of solids away from the floodplain areas targeted for subsequent removal. Silt fence was also used as an erosion control measure to protect sediment drainage piles.

During weather events that involved precipitation or strong winds, drainage piles were covered with plastic sheeting to protect the piles from erosion and infiltrating storm water.

3.6.2 Water Treatment

Water collected during sediment stabilization or construction dewatering was treated prior to being discharged back into the river. Each of these water treatment processes are described in Section 3.6.2.1 and 3.6.2.2. Both treatment systems were operated in accordance with the Substantive Requirements Document (SRD) – No. MIU990025 (MDEQ 2007). The SRD also included a variety of monitoring parameters for the discharge water. Compliance with the SRD is described in Section 3.6.2.3.

3.6.2.1 Sediment/Soil Drainage Water Treatment

The same water treatment system for sediment/soil drainage water was used sequentially at Staging Areas 1N, 3S, and 5S, while a separate treatment system was operated at Staging Area 4N. Water collected at Staging Area 2S was transported to Staging Area 1N for treatment by a vacuum truck.

A schematic of the water treatment system is included in Figure 7. The water treatment system trailers consisted of an influent stream that was split (right side [A-side] and left side [B-side]) and passed through two bag filters and two granular activated carbon vessels before re-combining to form the effluent stream. Most of the water was treated in batch operation. Treated final effluent water was collected in one of two 20,000-gallon holding tanks located at the staging areas.

Treated water was usually stored in the holding tanks until analytical results were received and it was deemed acceptable to discharge the water to the river. All treated water was sampled and monitored in accordance with the requirements of the SRD, described in Section 3.6.2.3. The influent sampling port was located before the T-junction separating the right and left sides of the treatment system, the mid-fluent sampling ports were located between the carbon adsorption tanks, and the effluent sampling ports were located before the holding tanks. During several short periods of high water generation due to significant precipitation/snow melt, water was continuously treated and discharged directly from the treatment system to the river.

Outfall locations are displayed on Figure 2. Active dates for the water treatment systems are listed in the table below.

Table 7 -- Water Treatment System Period of Use

Outfall Location	Date Activated	Date Removed
Staging Area 1N (Outfall 001)	July 2007	September 2007
Staging Area 3S (Outfall 003)	October 2007	May 2008
Staging Area 4N (Outfall 005)	May 2008	January 2009
Staging Area 5S (Outfall 002)	June 2008	November 2008

After treatment was no longer required at an outfall location, equipment was demobilized and either moved to the next downstream location or removed from the former Plainwell Impoundment project area.

3.6.2.2 Construction Dewatering Water Treatment

An individual treatment system designed for a maximum flow rate of 500 gpm was utilized for construction dewatering. This system was located on the western bank of Cofferdam Area 1 (Outfall 004). Construction dewatering of the Cofferdam Area 1 occurred in October and November 2007. Initial dewatering activities included pumping down water and discharging directly downstream at Outfall 004 (Figure 2).

Turbidity monitoring points were established to compare background readings to readings taken at the discharge point. When discharge point turbidity levels reached a level of two times the background level, water was directed to the 500 gpm water treatment system for treatment prior to discharge. The system sampling parameters are described in Section 3.5.3.

Water was pumped from the river to a set of four holding tanks to allow suspended sediments to settle out of the water. The water was then pumped to the water treatment system. The system initially consisted of an influent stream that was split and sent through parallel sand filtration units, then combined and sent to four bag filters and primary and secondary granular activated carbon vessels before discharge to the river. The influent sampling port was located before the T-junction separating the right and left sides of the treatment system; the mid-fluent sampling port was located between the primary and secondary carbon units; and the effluent sampling port was located before the discharge location. As noted below, the system was modified after initial operation by adding a 16-stage bag filtration unit to polish the final effluent prior to discharge (as seen in Figure 7). The system was in operation during October and November 2007.

All water treatment equipment was decontaminated and removed from the project area at the conclusion of water treatment activities. Wipe samples were collected from the equipment to verify they were properly decontaminated. Wipe sample results are included in Table 8 and laboratory reports are included in Appendix C-8. A schematic of the water treatment system is included in Figure 7.

3.6.2.3 Substantive Requirements Document Compliance

The water treatment systems were operated and the discharge water was monitored in accordance with the SRD, which specified the performance of the following measurements and inspections:

Table 9 -- Discharge Monitoring Parameters

Parameter	Frequency	Sample Type
Monitoring at Outfalls 001, 002, 003, 004, and 005 Influent		
Total PCBs (USEPA Method 608)	Weekly	Grab
Monitoring at Outfalls 001, 002, 003, 004, and 005 Mid-Fluent		
Total PCBs (USEPA Method 608)	Weekly	Grab
Monitoring at Outfalls 001, 002, 003, 004, and 005 Discharge		
Flow	Daily	Report Total Daily Flow
Total PCBs (USEPA Method 608)	Weekly	Grab
Total Suspended Solids (TSS) (USEPA Method 160.2)	Weekly	Grab
Total Phosphorus as P (USEPA Method 365.3)	Monthly	Grab
Equipment Inspection	3x per Week	Visual
Outfall Observation	Daily	Visual

- The daily discharge limitations were 0.20 µg/L for PCBs and 45 milligrams per liter (mg/L) for TSS.

- The average monthly discharge limitations were 1.6×10^{-7} pounds per day for PCBs and 30 mg/L for TSS.

- There was no daily or monthly discharge limitation for total phosphorus.

Water treatment samples were collected in accordance with the project-specific QAPP. Analytical data are presented in Tables 10 and 11, and laboratory reports are included in Appendices C-6 and C-7. Water treatment logs are included in the daily activity reports in Appendix A.

Visual inspections of the treatment systems’ components and discharges were performed as required by the SRD. Treatment system components including pumps and associated system piping were inspected two times per day for signs of leaks, mechanical noises, or vibrations (indicating signs of potential pump or component failure). All tanks, pipes, hoses, and associated connections were inspected twice daily for leaks or other signs of potential failure (e.g., cracked or leaking couplings, leaking valves). In addition, the system discharge was observed two times per day to identify signs of unusual turbidity, color, oil films, floating solids, settleable solids, suspended solids, or foams. No changes in water quality were observed throughout the course of work activities.

As required by the conditions of the SRD, monthly reports were maintained throughout the project detailing the volume of water treated and discharged, sample dates, sample results, daily inspections, and monthly loading calculations. These reports were not submitted to the MDEQ, but were maintained onsite. Year end reports titled *Former Plainwell Impoundment Plainwell Dam, near 12th Street, Plainwell, MI Retained Self-Monitoring Requirements* were submitted to MDEQ on January 10, 2008 (ARCADIS 2008k), and on January 9, 2009 (ARCADIS 2009b) to document that year-to-date logs were maintained and that no significant changes in water quality occurred to the discharge. Although minor adjustments were made to the outfall locations to accommodate modifications to staging area placement, the outfalls remained approximately at the locations described in the SRD. On July 1, 2009, ARCADIS submitted to MDEQ a letter titled *Former Plainwell Impoundment Plainwell Dam, near 12th Street, Plainwell, MI Treatment System Closure* (ARCADIS 2009c) to notify MDEQ that discharge had stopped and all equipment was removed from the project area.

Discharge Frequency

The discharge limitations in the SRD were based on the water treatment systems treating and discharging water on a continuous basis. However, with the exception of three rainfall/snow melt events, the volume of water generated during sediment dewatering did not require continuous treatment, so batches of water were treated, sampled, held in holding tanks, and discharged after analytical results were received. Water was retreated if PCBs were detected in the effluent sample.

During periods of significant rainfall or rapidly melting snow in February 2008, September 2008, and December 2008, water was continuously treated and discharged due to the large volume of water collected at the operating staging areas. Continuous treatment never occurred for more than 1 week. During these events, at least one sampling event was performed to document discharge conditions, as required by the SRD. As described below, PCBs were detected once in an effluent sample while treating and discharging water continuously. However, the PCB concentration did not exceed the quantification level provided in the SRD.

Activated Carbon Treatment

The water treatment system was configured with two identical parallel systems which included activated carbon. The activated carbon was replaced about every 6 months and disposed at the same landfills as the excavated and processed soil and sediment. Waste manifests for carbon disposal were maintained onsite. If during the course of the project PCBs were detected on one side of the treatment system, operation of that side of the system was suspended until the situation could be evaluated and the activated carbon replaced if necessary. The other side of the system could continue to be used to treat water until the side of the treatment system where the PCBs were detected was brought back on line.

TSS and PCB Detections

On October 26, 2007, the effluent TSS concentration sample in the 500 gpm construction dewatering system exceeded the daily discharge limit as specified in the SRD. The MDEQ was verbally notified of the non-compliance on October 29, 2007 and a written report detailing the non-compliance titled *Former Plainwell Impoundment Plainwell Dam, near 12th Street, Plainwell, MI Noncompliance Notification* (ARCADIS BBL 2007g) was submitted to MDEQ and USEPA on October 31, 2007. Modifications were made to the system in an effort to reduce the TSS concentration of the final discharge by using finer grain sand in the sand filtration units and smaller pore size bags in the bag filtration units, and by installing a 16-stage bag filtration unit on the output side of the activated carbon unit. On November 9, 2007, the modified system was placed back in operation with the final effluent discharged back into Cofferdam Area 1 to ensure the system could meet the SRD concentration limitations. Based on visual observations that indicated a lack of reduction in the TSS levels following the modifications, the water that remained in the 500 gpm system was drained and hauled to the smaller water treatment system located at Staging Area 3S for treatment.

Due to a rapid recharge rate in the cofferdam area and the treatment system's inability to control TSS, the 500 gpm system was taken offline in November 2007. The system was decontaminated and demobilized from the project area. No further efforts were made to dewater Cofferdam Areas 1 and 2.

On September 17, 2008 during a significant rainfall event, PCBs were detected in the construction dewatering water treatment system effluent discharged to the river from Staging Area 5S at a concentration of approximately 0.05 µg/L (this result is the average of sample results from the right effluent port [0.1 µg/L] and the left effluent port [<0.1 µg/L]). Because there was no excess capacity in the treatment system at this time, water was being treated and discharged continuously and could not be held for retreatment. However, the PCB concentration discharged did not exceed the quantification level of 0.2 µg/L established in the SRD.

PCBs were also detected (0.2 µg/L) in the mid-fluent sample collected from the right side of the treatment system on September 17, 2008. Because this value was equivalent to the daily discharge limit specified in the SRD, operation of the right side of the treatment system was suspended and water was only treated and disposed from the left side. On September 30, 2008, MDEQ determined that because the mid-fluent detection occurred during a significant rainfall event, it was not representative of the normal operation of the activated carbon, and therefore normal water treatment operations were allowed to continue without replacing the activated carbon (MDEQ 2008). Batch treatment of the water resumed after the week of September 15 so that mid-fluent and final effluent concentrations could be monitored before discharging the water.

3.7 Transportation and Disposal of Sediment and Soil

Transportation and disposal activities were performed in accordance with the Traffic Control Plan (ARCADIS BBL 2007f). Key points are summarized below.

Stabilized soil and sediment was transported via 35-ton gravel trucks to one of three offsite landfills. Prior to transporting any material to the landfills, waste characterization samples were collected from Removal Area 1. Waste characterization parameters were determined through communication with the receiving landfill. Two samples were collected on May 7, 2007 and submitted to KAR Labs for analysis of PCBs, TCLP VOCs, TCLP Metals, TCLP SVOCs, reactivity, corrosivity, ignitability, herbicides, and pesticides. Analytical results were submitted to the receiving landfill prior to disposal of excavated materials. Waste characterization results are included in Table 11 and laboratory reports are included in Appendix C-7.

Non-TSCA classified soils and sediments were transported to either the C&C Landfill located in Marshall, Michigan or the Ottawa County Landfill located in Coopersville, Michigan. TSCA soils and sediments were transported to Wayne County Landfill located in Belleview, Michigan. All soils and sediments were manifested for offsite disposal (Appendix N). In addition to soils and sediments, other materials such tree stumps generated during clearing and grubbing of removal areas and debris generated during demolition of the remains of the former dam powerhouse were also manifested and transported to the appropriate landfill for disposal.

Truck liners and sealed tailgates were used to reduce spillage or leakage onto public roadways, and truck bed covers were used to prevent fugitive dust during transportation. Before leaving the project area, each truck transporting materials that passed through an exclusion zone was decontaminated by either using pressure washers or an automatic tire wash. Water used to wash trucks was collected at the drainage basin of each staging area, combining with the dewatering water to be treated.

3.8 Bank Stabilization and Habitat Reconstruction

One objective of the removal action was to improve the stability of the river banks within the former Plainwell Impoundment. Prior to the TCRA, many of the river banks in the project area were steep and under cut, and susceptible to erosion and sloughing. Another objective of the TCRA was habitat reconstruction/enhancement, which included the revegetation of disturbed areas and ecological improvement of the affected locations.

As near-shore material was removed, the banks of each removal area were stabilized and restored to minimize bank erosion and provide areas suitable for habitat reconstruction. Above the water line, most banks were graded to a 3:1 slope, while in designated areas banks were graded to a 15:1 slope to facilitate more extensive habitat enhancement (Figures 8.1 to 8.8). The basis of design is described in Section 2.7 of the Design Report (ARCADIS BBL 2007a).

3.8.1 Bank Stabilization Materials

Banks were stabilized using a combination of sand backfill and river run rock to create stable slopes and minimize potential erosion. Topsoil was installed as necessary to support revegetation. These materials are discussed below.

3.8.1.1 Backfill

Clean sand backfill material was placed in some removal areas to bring the bank and floodplain elevations back to original grade or to reconstruct areas that experienced erosion due to high flow events. Material used for backfill came from an offsite source and was sampled as described in Section 3.2.3. Backfill was placed in Removal Area 1 according to the design to bring the elevation after construction activities to the original elevation. Backfill was placed in all upland removal areas to bring the areas to original elevation to promote habitat restoration and to prevent safety hazards associated with abrupt, unexpected elevation changes. Backfill was placed in Removal Areas 6B and 7 to reconstruct banks that experienced erosion dues to high water events as described in Section 3.11. Backfill sampling results are included in Table 1. Material specifications for the backfill are included in Appendix D and laboratory data are included in Appendix C-1.

3.8.1.2 River Run Rock

Banks subject to higher erosional stresses were armored with river run rock. River run rock was also installed immediately upstream and downstream of the WCS on both sides of the river in the western channel. Approximately 48-percent of the linear footage of the bank was armored with river run rock. Non-woven geotextile was installed under river run rock. River run rock consisted of commercial quarried rounded stone, free of debris with a mean stone diameter of 4 inches. River run rock was inspected and approved by ARCADIS prior to use. A material certification for the river run rock is included in Appendix D.

3.8.1.3 Topsoil

Approximately 6 inches of topsoil purchased from an offsite source was installed in all bank and floodplain areas prior to seeding. Topsoil was sampled as outlined in Section 3.2.3 and approved by ARCADIS prior to use. Soil sampling results are included in Table 1. Material certifications for the topsoil are included in Appendix D and laboratory data are included in Appendix C-1.

3.8.2 Vegetation and Riparian Habitat Establishment

Vegetation and riparian habitat was established by seeding and planting in three different hydrologic zones. The basis for the design of these zones is described in Section 2.7 of the Design Report (ARCADIS BBL 2007a). Native plant species provided by a local nursery were used throughout planting activities. Plant species were reviewed and approved by ARCADIS prior to use. Following installation of woody vegetation, saplings were tied to two stakes for support and all species were surrounded with a ring of woody mulch. See Appendix O for planting records.

The three hydrologic zones were identified as Zones 1, 2, and 3 as shown on Figures 8.1 to 8.8. The plant species and densities are shown on Figure 8.9

- Zone 1 vegetation consisted of dense-rooting plants and hydrophytic species to establish an emergent scrub-shrub wetland habitat to stabilize the bank. The selected species are tolerant of being submerged. Native seed mixtures were planted before installation of a biodegradable erosion control fabric. Willow stakes were installed with the fabric but were limited to rows near the water's edge.

- Zone 2 vegetation consisted of woody tree and shrub plantings to establish a scrub-shrub, early successional forest community. Native seed mixtures were planted before installation of biodegradable erosion control fabric.

- Zone 3 vegetation consisted of trees and shrubs to restore and enhance the riparian area transitioning to drier conditions. Prior to installation of plants and shrubs, native seed and grass species were installed and covered with biodegradable erosion control fabric or straw. Trees were planted to mimic natural conditions.

3.8.3 Habitat Enhancement

Three unique locations in the project area presented opportunities for additional habitat enhancement and are described in the following sections.

3.8.3.1 Removal Area 1

Removal Area 1 was located close to residential properties and, prior to construction, contained areas of high quality habitat that included riparian hardwood forest, emergent wetland with trees, and emergent wetland. Restoration activities for all three types of habitats included seeding with a native seed mixture and replanting trees and shrubs. The emergent wetland habitat was improved by seeding with a more diverse plant mix than was present prior to construction.

3.8.3.2 Northern Bank Area

Habitat in the Northern Bank Area throughout Removal Areas 11A, 12A, and 13A was enhanced by flattening the slope of the bank and floodplain to increase the area of inundated floodplain that would support the evolvement of emergent wetland habitats.

Excavation activities occurred in two stages for Removal Areas 11A, 12A, and 13A. Materials targeted for removal were excavated down to an interim neat line, and the excavation of targeted materials area was confirmed with the same soil sampling procedures used throughout the rest of the TCRA. Once analytic data confirmed that no further excavation was necessary for removal of targeted materials, the second stage of excavation occurred. Material in this second stage of removal was excavated to the final neat line and regraded to provide an active floodplain necessary for the development of emergent wetland habitats. The basis of the design is detailed in Section 2.1.4.3 of the Design Report (ARCADIS BBL 2007a).

3.8.3.3 Southern Bank Area

Similar to the Northern Bank Area, the Southern Bank Area provided an opportunity for additional habitat enhancement to support the development of emergent wetland habitats. The Southern Bank Area includes Removal Areas 6B, 7, and 8. Creating a flat shelf along the bank increased the area of inundated floodplain. Excavation occurred in one stage to remove targeted materials and then the final grade was established as described in the Design Report.

3.8.4 Habitat Reconstruction of Excavated Areas

Excavated areas were revegetated and reconstructed as described above. Initial reconstruction of a removal area – installation of river run rock (if needed), placement of backfill, placement of topsoil, installation of erosion control blanket, and seeding – was performed at the conclusion of removal activities in each area. Planting of trees and shrubs was generally performed as species availability and planting seasons dictated. Habitat reconstruction of each of the removal areas is summarized below and shown on Figures 8.1 to 8.8.

Removal Area 1

Removal Area 1 was backfilled to original grade using clean fill materials in June and July 2007. Six inches of topsoil were installed in August 2007. The area was seeded with species designated for Planting Zone 1 in August and September 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 2A

Six inches of topsoil were installed in Removal Area 2A in August 2007. The area was seeded with species designated for Planting Zone 1 in August and September 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 2B

Topsoil was not installed in Removal Area 2B. River run rock armament was installed along the toe-of-slope to the prism out median flow in August 2007. The area was seeded with species designated for Planting Zone 1 in October 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 3A

River run rock armament was installed along the toe-of-slope to the prism out median flow in August 2007. Six inches of topsoil was installed in the floodplain in August 2007, and the area was seeded with species designated for Planting Zones 1 and 3 in September 2007. Trees and shrubs were planted from May through October 2008.

Upland Removal Areas 3A1 and 3A2

Upland Areas 3A1 and 3A2 were backfilled to original grade using clean fill materials in August 2007, and 6 inches of topsoil was installed in August 2007. The areas were seeded with species designated for Planting Zone 3 in September 2007. Straw was placed over the seed to provide erosion control. Trees and shrubs were planted from May through October 2008.

Removal Area 3B

River run rock armament was installed along the toe-of-slope to the prism out median flow in August 2007. Six inches of topsoil was installed in the floodplain in September 2007. The floodplain area was seeded with species designated for Planting Zone 1 in October 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 4A

Six inches of topsoil were installed in the floodplain in September 2007. The area was seeded with species designated for Planting Zones 1 and 3 in September 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 4B

Six inches of topsoil were installed in the floodplain and bank areas in September 2007. The areas were seeded with species designated for Planting Zone 1 in October 2007. Temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Upland Removal Area 4B1

Upland Removal Area 4B1 was backfilled to original grade using clean fill materials in August 2007, and 6 inches of topsoil was installed in September 2007. The area was seeded with species designated for Planting Zone 3 in October 2007. Straw was placed over the seed to provide erosion control. Trees and shrubs were planted from May through October 2008.

Removal Area 5

Six inches of topsoil was installed in the floodplain in September 2007. The area was seeded with species designated for Planting Zones 1 and 2 in September 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 6A

River run rock armament was installed along the toe-of-slope to the prism out median flow in August 2007. The area was seeded with species designated for Planting Zone 2 in August 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Removal Area 6B

Six inches of topsoil was installed between September and October 2007. The area was seeded with species designated for Planting Zones 1, 2, and 3 in October 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

The area was seeded with species designated for Planting Zones 1, 2, and 3 in July 2007. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May through October 2008.

Upland Removal Area 6B1

Upland Removal Area 6B1 was backfilled to original grade using clean fill materials in October 2007. Six inches of topsoil was installed in October 2007. The area was seeded with species designated for Planting Zone 3 in October 2007. Straw was placed over the seed to provide erosion control. Trees and shrubs were planted from May through October 2008.

Removal Area 7

Initial restoration activities included installation of 6 inches of topsoil in November 2007. High river water levels in late 2008 and early 2009 prevented additional restoration at that time. In late December 2008, erosion was observed in the upstream portion of the removal area. Additional aggregate, backfill, and topsoil were installed to mitigate the erosion.

Restoration continued after the erosion protection system was installed. Six inches of additional topsoil, additional seed, erosion control blanket, and plants were installed. This additional restoration work began in June 2008 and concluded in June 2009.

Removal Area 8

A temporary erosion control blanket was installed following excavation in December 2007 to minimize erosion until topsoil and seed could be applied to the area during the following construction season. Restoration activities continued into the Phase 2 construction season. Six inches of topsoil were installed in June 2008. The area was seeded with species designated for Planting Zone 1 in June 2008. A new temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from June 2008 through June 2009.

Removal Area 9A

River run rock armament was installed along the toe-of-slope to the prism out median flow and 6 inches of topsoil was installed in the floodplain in May 2008. The area was seeded with species designated for Planting Zone 3 between June and October 2008. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from June 2008 through June 2009.

Removal Area 9B

Six inches of topsoil was installed in the floodplain in April 2008. The area was seeded between April and October 2008 with species designated for Planting Zones 1 and 3. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from July 2008 through June 2009.

Removal Area 10A

River run rock armament was installed along the toe-of-slope to the prism out median flow in May 2008. Six inches of topsoil was installed in the floodplain in May 2008. The area was seeded with species designated for Planting Zones 1, 2, and 3 commencing in June 2008 and concluding in October 2008. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from June 2008 through June 2009.

Removal Area 10B and Upland Removal Area 10B1

River run rock armament was installed along the toe-of-slope to the prism out median flow between June and July 2008. Six inches of topsoil was installed in the floodplain in July 2008. The area was seeded with species designated for Planting Zones 1, 2, and 3 between July 2008 and October 2008. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from July 2008 through June 2009.

Upland Removal Area 10B1 was backfilled to original grade using clean fill materials between May and July 2008. Six inches of topsoil was installed above the fill material in July 2008. The area was seeded with species designated for Planting Zones 1 and 2, between July and October 2008. Straw was placed over the seed to provide erosion control. Trees and shrubs were planted from July 2008 through June 2009.

Removal Area 11A and Upland Area 11A1

Six inches of topsoil was installed in the floodplain in September and October 2008. The area was seeded with species designated for Planting Zones 1, 2, and 3 in October and November 2008, and temporary erosion control blanket was positioned and secured over the seed. Tree and shrub planting activities were performed between June 2008 and June 2009.

Removal Area 11B

River run rock armament was installed along the toe-of-slope to the prism out median flow in June and July 2008. Six inches of topsoil was installed in the floodplain in July 2008. The area was seeded with species designated for Planting Zones 1 and 3 in October 2008. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from July 2008 through June 2009.

Removal Area 12A and Upland Area 12A1

Six inches of topsoil was installed in the floodplain of Removal Area 12A and Upland Area 12A1 in September and October 2008. The areas were seeded with species designated for Planting Zones 1, 2, and 3 in October and November 2008. A temporary erosion control blanket was positioned and secured or straw was placed over the seed for erosion control purposes. Trees and shrubs were planted from November 2008 through June 2009.

Removal Area 12B

River run rock armament was installed along the toe-of-slope to the prism out median flow in July 2008. Six inches of topsoil was installed in the floodplain areas in July 2008. The areas were seeded with species designated for Planting Zones 1 and 3 in July 2008. A temporary erosion control blanket was positioned and secured over the seed. Tree and shrub planting activities were performed between July 2008 and June 2009.

Removal Area 13A and Upland Area 13A1

Six inches of topsoil were installed in the floodplain area in November 2008 and May 2009. A temporary erosion control blanket was installed following excavation in November 2008 to minimize erosion during the winter shutdown period until topsoil and seed could be applied to the remaining area during the following spring. The area was seeded with species designated for Planting Zones 1, 2, and 3 in May 2009. A temporary erosion control blanket was positioned and secured, and straw was placed over the seed for erosion control purposes. Trees and shrubs were planted from May 2008 through June 2009.

Removal Area 13B

River run rock armament was installed from the toe-of-slope to the prism out median flow in April and October 2008. Six inches of topsoil was installed in the floodplain in November 2008. The area was seeded with species designated for Planting Zone 3 in May 2009. A temporary erosion control blanket was positioned and secured over the seed. Trees and shrubs were planted from May 2008 through June 2009.

Mid-Channel Areas

No restoration activities occurred in Mid-Channel Areas A, B, or C because they were excavated below the water line and were not part of the bank restablization efforts.

Island Removal Areas

Restoration activities were not required on Islands 1 or 2.

On Island 3, river run rock armament was installed along the toe-of-slope to the prism out median flow in August 2007. Six inches of topsoil was installed in the floodplain in September 2007. The area was seeded with species designated for Planting Zone 1 in September 2007. Straw was placed over the seed to provide erosion control. Tree and shrub planting activities were performed as appropriate from May 2008 through June 2009.

Cofferdam Removal Area 1

On the western bank ("B" side) of Cofferdam Area 1, restoration activities were sequenced to remove equipment while performing restoration work. River run rock armament was installed in November and December 2007. The downstream portion of the removal area was backfilled to original grade using clean fill materials in November because during creation of the access road, material not intended for removal was graded to provide access to the area. Six inches of topsoil was installed in the backfilled area in November 2007 and April 2008, depending on the location of the work area. Similarly, the area was seeded with species designated for Planting Zone 1 in both November 2007 and April 2008. Tree and shrub planting activities were performed in May and June 2009.

The eastern bank ("A" side) of Cofferdam Area 1 was the earthen embankment of the former Plainwell Impoundment. River run rock was installed during the 2007 excavation activities because the embankment was accessible at that time. River run rock was installed to protect the embankment from higher flow velocities as this embankment served as the eastern bank of the new channel when river flow was directed through the western channel at the completion of the TCRA. After the storm event in September 2008 (Section 3.11), the river run rock installed on the embankment was shifted at the request of the MDNR to protect the toe-of-slope in the area. The rock was installed from the toe-of-slope to the dam-out median water line. The top of the embankment, formerly covered by rock, was graded to a flat top. The original extent of river run rock and the regraded top of embankment can be seen on Figure 8.1. In November 2008, 6 inches of topsoil was installed. Seeding activities occurred in May 2009. A temporary erosion control blanket was positioned and secured over the seed.

Cofferdam Area 2

No restoration activities occurred in the Cofferdam Area 2 because it was under water and not subject to bank stabilization efforts.

3.9 Removal of Phase 1, Phase 2 Cofferdams, and the WCS

The Phase 1 Cofferdam, Phase 2 Cofferdam, and WCS were removed as excavation activities in the each area were completed. The Phase 1 Cofferdam was removed in the spring of 2008 following the conclusion of Phase 1 activities, while the WCS and Phase 2 Cofferdam were removed at the conclusion of Phase 2 activities. Now that the TCRA is complete, the Kalamazoo River no longer flows over the remains of the former Plainwell Dam spillway, but rather flows freely through the restored western channel.

3.9.1 Phase 1 Cofferdam Removal

Removal of the Phase 1 Cofferdam began during the week of April 21, 2008. Water was pumped into Cofferdam Area 1 from the Kalamazoo River to equalize the water level on either side of the cofferdam. On April 30, 2008, Sheet Pile 22, located at Station P1 2+20, was removed from the Phase 1 Cofferdam and the water on either side of the cofferdam was equilibrated. The majority of the sheet pile wall was removed between May 2 and May 16, 2008 using a vibratory hammer. The junction pile remained in place to facilitate construction of the Phase 2 Cofferdam. In addition, three pairs of sheet pile could not be removed using a vibratory hammer. These sheets were removed with the impact hammer at the conclusion of Phase 2 construction activities. The sheets that remained in place during Phase 2 construction activities did not obstruct the flow of water over the WCS.

Sheet piling was generally removed in the opposite direction it was installed. Sheet pile removed from the Phase 1 Cofferdam was decontaminated, inspected for damage, and if possible, reused as a part of the Phase 2 Cofferdam.

Two pairs of sheets could not be removed and remained in place until January 30, 2009. With the approval of the regulatory agencies, the sheets were cut 6 inches below the riverbed elevation. The top portions were removed, and the subsurface portion remained in place (Figure 5).

3.9.2 Phase 2 Cofferdam Removal

Removal of the Phase 2 Cofferdam began on January 2, 2009. Sheet pile was generally removed in the opposite direction it was installed using a vibratory hammer. Larger impact hammers were required to remove sheets that could not be removed using the vibratory hammer. Ten pairs of sheet pile could not be removed from the Phase 2 Cofferdam. With the approval of the regulatory agencies, the sheets were cut at the riverbed elevation between January 29 and 30, 2009; the top portions were removed and the subsurface portion remained in place (Figure 5). Sheet pile removed from the Phase 2 Cofferdam was decontaminated, inspected for damage, and sold to King Construction for reuse or recycling.

3.9.3 WCS Removal

Removal of the WCS began on October 16, 2008 by removing stop logs to lower the water elevation. The WCS was removed in the opposite order of its construction. First, the stop logs and the stop log removal system were disconnected, and then the walkway, cross-bracing, and H-piles were removed. Removal of the wing and cut off walls began during the week of October 27, 2008. The wing and cut off walls were removed, from east to west using a vibratory hammer or rock hammer. Larger hammers were mobilized as necessary to remove sheet piling that had been bent during installation or broke during removal. The hammers were operated from the land, temporary docks, or barges, depending upon accessibility. Five pairs of sheet pile could not be removed from the Phase 2 Cofferdam. With the approval of the regulatory agencies, the sheets were cut at the riverbed elevation on February 19 and 20, 2009; the top portions were removed and the subsurface portion remained in place. Removed sections of the WCS were decontaminated, as necessary, and staged at Staging Area 4N prior to removal. The WCS removal was completed during the week of February 23, 2009 restoring the western channel to a surface at elevation 696 feet NGVD 29.

3.10 Project Area Restoration and Demobilization

Following completion of the required soil/sediment removal and cofferdam/WCS removal activities, project area restoration activities were performed as necessary. Upon completion of the project area restoration activities, all debris was collected and disposed at an appropriate offsite disposal facility and all contractor equipment was demobilized. Additional details regarding each of these activities are provided below.

3.10.1 Restoration of Disturbed Vegetation

In accordance with Section 3.9 of the Design Report (ARCADIS BBL 2007a), grubbed areas that were originally vegetated (fields, vegetated areas, etc.) were restored. These areas include access roads and staging areas. The habitat of each removal area was reconstructed as described in Section 3.8.4. In areas requiring installation of grass seed, a 6-inch layer of topsoil was placed to restore pre-excavation grades, followed by placement of grass seed and straw or erosion control blanket. New trees and shrubs were installed in accordance with the appropriate vegetation zone in which the disturbed area was located.

3.10.2 Access Roads and Staging Areas

Staging areas were removed and revegetated as removal work progressed downstream. At each staging area, the top 6 inches of aggregate material was initially removed and disposed of at the offsite landfill with the stabilized soil and sediment. Aggregate material that remained on the staging area was used for construction of another staging area. Sand used to grade and berm the staging area during construction was staged for use at a future staging area. Geotextile liner and fabric was removed and disposed of at the offsite landfill.

Following the completion of the project, all aggregate, sand, and geotextile materials used for staging area construction were mixed with sediments/soils that were disposed offsite. Each staging area was then graded back to its original elevation. Staging Areas 1N, 3S, and 4N were seeded and covered with straw for erosion control. Appropriate Zone 3 plant species were installed at the staging areas as shown on Figures 8.1 to 8.8. Vegetation was not installed at Staging Areas 2S and 5S at the property owner’s request to only grade the underlying materials to their original condition.

Access roads were removed as possible as work progressed downstream. Some access roads remained in place to facilitate revegetation efforts or at the request of the property owner. The top 6 inches of aggregate material was removed from all roads and disposed at an offsite landfill. If the road was to be left in place, no further action was taken. If the road was to be removed, the remaining aggregate material was reused on subsequent roads and geotextile fabric was disposed at the offsite landfill. Roads that were fully removed were covered with 6 inches of topsoil, seeded, planted with Zone 3 plantings, and covered with straw for erosion control. Table 12 summarizes the removal and restoration of access roads.

Table 12 -- Status of Access Roads

Access Road	Status
Northern side of river, Removal Areas 1-6	Removed
First Street to Staging Area 1N	Left in place
Northern side of River, Removal Areas 9-13	Left in place (will be removed)
Miller Road to Staging Area 4N	Left in place
Southern side of river, Removal Areas 2-4	Left in place
M-89 to Staging Area 2S	Left in place
Southern side of River, Removal Areas 6-10	Left in place (will be removed)
Southern side of River, Removal Areas 11-13	Removed
From parking lot to Staging Area 3S	Left in place

The access road located on the northern side of the river between Removal Areas 9 through 13 and the access road located on the southern side of river between Removal Areas 6 and 10 will be removed before the conclusion of post-removal control, as described in Section 4. If aggregate material from these areas is reusable, it will be utilized as a part of future KRSG-implemented removal activities along the Kalamazoo River; if it is unusable, it will be disposed at an offsite landfill.

3.10.3 Contractor Demobilization

At the completion of project area restoration activities, contractor equipment, temporary trailers, and temporary erosion and sedimentation control measures were removed from the project area. Security fencing was left in place as necessary to control access to the project area.

3.11 September 2008 Storm Event

In September 2008 the remnants of Hurricane Ike hit the Kalamazoo area. Approximately 7.5 inches of precipitation were recorded over a 48-hour period on September 12 through 14, causing a rapid rise in water levels (approximately 5 feet) in the Kalamazoo River. The maximum river flow rate recorded during this storm event at the Comstock gauge, located in Kalamazoo, Michigan, was 5,660 cfs on September 18, 2008. That flow rate corresponds to a 50-year flow return frequency. In comparison, the river flow rate on September 12, 2008, before the heavy rains began, was 673 cfs. For comparison, the mean flow rate at the Comstock gage (based on 70 years of data through August 2009) is 585 cfs.

Also on September 18, 2008, the third highest crest (10.43 feet) on record was recorded at the Comstock gage. According to the USGS, a crest of 10.43 feet falls between a moderate flood stage (10 feet) and a major flood stage (11 feet).

Work was performed to protect Staging Area 5S, protect the island between the Phase 2 Cofferdam and WCS, and remove pressure on the WCS and Phase 2 Cofferdam. The following events occurred following the storm event to limit the impact of the event on the TCRA:

- Water overtopped the Phase 2 Cofferdam overflow weir on September 13, 2008 and began flowing over the Plainwell Dam spillway on September 14, 2008, as designed. To address increasing water level elevations, the southern half of the cofferdam was cut off at the emergency overflow weir height to increase the volume of water that could flow over the top of the cofferdam. The northern half of the Phase 2 Cofferdam remained at its constructed elevation.

- On September 14, 2008, erosion of the earthen embankment between the WCS and Phase 2 Cofferdam was observed. All stop logs were removed from the WCS to maximize the flow of water over the WCS and away from the embankment. Debris was removed from the WCS as much as possible to increase water flow over the structure. A survey was performed on September 17, 2008 to identify the extent of erosion on the embankment.

- Five additional pairs of steel pile were driven from the termination point of the Phase 2 Cofferdam near the embankment directly east to the former spillway wing wall. The sheet pile prevented water from flowing over the embankment and directed it towards the former spillway. See Figure 5 for additional information.

- Gabion baskets were installed along the embankment and covered in concrete grout in an attempt to prevent further erosion of the embankment. An estimated 40 to 50 feet of material eroded from the embankment area. After the gabion baskets were installed, the slope was further stabilized with grout and concrete blocks. During the week of September 22, 2008, additional sheet pile and jersey barriers were installed to reduce the flow of water into the Phase 2 Cofferdam Area.

- Additional river run rock was installed on the west side of the western channel downstream of the WCS. A combination of rock, grout, gabion baskets, and concrete blocks was installed to address erosion observed at that location. See Figure 8.1 for additional information.

- A gravel berm was constructed on the northern side of Staging Area 5S to prevent potential flooding of the staging area.

3.12 Summary

Construction activities were performed in two phases between May 2007 and June 2009. Phase 1 construction activities were performed between May 2007 and January 2008; Phase 2 construction activities were performed between March 2008 and June 2009. The removal action generally progressed from upstream to downstream, and both sides of the river were excavated simultaneously throughout much of the TCRA. Construction activities included the installation and removal of two cofferdams and one WCS to hydraulically isolate areas for targeted material removal and water level control within the river.

Vegetation was cleared as necessary to support construction activities. Soil and sediment from 13 removal areas, three mid-channel areas, three island areas, two cofferdam areas, and seven upland floodplain areas were excavated from the former Plainwell Impoundment. Approximately 126,700 cy of material was removed and disposed at commercial offsite landfills. This material consisted of approximately 20,860 cy of TSCA material and 105,840 cy of non-TSCA material. Approximately 250 soil confirmation samples were collected from the bank and floodplain areas to confirm completion of excavation. Surface elevations were used to confirm excavation in near-shore and mid-channel sediment removal areas. Banks were stabilized and revegetated at the conclusion of removal activities. Table 13 summarizes construction activity at each area. The total cost to the KRSG for construction activities and associated engineering support was approximately $28 million dollars.

Table 13 -- Summary of Removal and Habitat Reconstruction Activities

Removal Area	Excavation Date		Habitat Reconstruction / Revegetation Date		Habitat Reconstruction/Revegetation Type		
	Start	End	Start	End	Backfill	River Run Rock	Woody Vegetation
1	Jun-07	Jul-07	Jun-07	Oct-08	X		X
2A	Jun-07	Jul-07	Aug-07	Oct-08			X
2B	Aug-07	Aug-07	Oct-07	Oct-08		X	X
3A	Jun-07	Jul-07	Aug-07	Oct-08		X	X
3A1	Jul-07	Jul-07	Aug-07	Oct-08	X		X
3A2	Jul-07	Jul-07	Aug-07	Oct-08	X		X
3B	Aug-07	Sep-07	Aug-07	Oct-08		X	X
4A	Jul-07	Jul-07	Sep-07	Oct-08			X
4B	Aug-07	Aug-07	Sep-07	Oct-08			X
4B1	Aug-07	Aug-07	Aug-07	Oct-08	X		X
5	Jul-07	Aug-07	Sep-07	Oct-08			X
6A	Jul-07	Aug-07	Aug-07	Oct-08		X	X
6B	Sep-07	Jun-08	Jul-08	Jun-09	X	X	X
6B1	Oct-07	Oct-07	Oct-07	Oct-08	X		X
7	Oct-07	Jun-08	Jun-08	Jun-09	X	X	X
8	Nov-07	Dec-07	Oct-07	Jun-09			X
Island 1	Sep-07	Sep-07					
Island 2	Sep-07	Sep-07					
Island 3	Jul-07	Aug-07	Aug-07	Oct-08		X	X
Cofferdam Area 1	Oct-07	Jan-08					
Cofferdam Area 1 Embankment	Nov-07	Dec-07	Nov-07	Jun-09		X	X
9A	Apr-08	May-08	May-08	Jun-09		X	X
9B	Apr-08	Apr-08	Apr-08	Jun-09			X
10A	May-08	May-08	May-08	Jun-09		X	X
10B	Apr-08	Jun-08	Jun-08	Jun-09		X	X
10B1	Apr-08	Jun-08	May-08	Jun-09	X		X
11A	May-08	Jan-09	Sep-08	Jun-09			X
11A1	May-08	Aug-08	Sep-08	Jun-09			X
11B	May-08	Jul-08	Jun-08	Jun-09		X	X
12A	Jun-08	Sep-08	Sep-08	Jun-09			X
12A1	May-08	Aug-08	Oct-08	Jun-09			X
12B	Jun-08	Jul-08	Jul-08	Jun-09		X	X
13A	May-08	Jan-09	Nov-08	Jun-09			X
13A1	Jan-09	Jan-09	Nov-08	Jun-09			X
13B	Mar-08	Oct-08	Apr-08	Jun-09		X	X
Mid Channel A	Aug-08	Oct-08					
Mid Channel B	Jul-08	Aug-08					
Mid Channel C	May-08	May-08					
Cofferdam Area 2	Sep-08	Dec-08					

4. Post-Removal Controls

Monitoring and maintenance activities will be conducted as described in Section 5.6 of the Design Report to evaluate the stability of restored banks and the development of upland and wetland habitats to meet vegetation performance standards.

4.1 Bank and Floodplain Monitoring

The restored banks and floodplain habitats will be monitored to document progress toward meeting the restoration goals. Restoration goals include the revegetation of disturbed areas and of creation stable channel banks. Observations were made throughout construction activities to allow early identification of conditions that required immediate response. These qualitative inspections were performed to:

1) Inspect banks and structures for signs of erosion before vegetation became too dense for observations.

2) Evaluate the health and development of seeded and planted vegetation.

3) Identify any deficiencies or damages that required maintenance.

Monitoring of restored bank areas will be performed annually for 3 years, and will include at least one observation after a 2-year flood event, should such an event occur during the 3-year period. The monitoring period will begin when this Completion Report is approved by USEPA.

An annual report will be prepared to document the progress of the restored areas toward meeting the performance standards, describe any maintenance activities required to adaptively manage restored habitats, and provide photo documentation of observations of restored and constructed habitats and bank areas. If performance standards are met within the required monitoring period, then the habitat will be accepted as a successful restoration. If banks or habitats do not meet performance standards within the required monitoring period, adaptive management will be incorporated into maintenance activities.

The following sections describe the specific methodologies that will be used to monitor restored banks and habitats, and identify the performance standards that were developed to evaluate the performance and stability of the restored areas.

4.2 Post-Construction Inspection

The first annual post-construction bank inspection was performed in June 2009. Representatives of the KRSG, USEPA, MDEQ, and MDNR walked the stabilized areas to inspect the banks. The inspection included looking for the following:

- Obvious signs of gullying or rill erosion
- Bank undercutting
- Signs of sloughing (i.e., cracking or bulging visible at the surface)
- Loss of armoring materials (i.e., loss of rock, erosion control matting, and/or vegetation)
- Any obvious signs of lateral bank movement (i.e., due to erosion or deposition)

The objective of bank monitoring activities was to evaluate the functionality of restored river banks towards the overall stability of the river system, its floodplain, and its associated riparian habitat. Monitoring objectives did not focus specifically on whether or not erosion was occurring, but on whether any erosion was jeopardizing the stability of the river system or its top of bank land uses. Lateral erosion was considered acceptable if it was associated with natural river processes that increased the interaction of the Kalamazoo River with its floodplain.

During the inspection, areas of potential erosion were observed near Removal Area 8B and Removal Area 9. Due to high water levels during restoration activities, this area could not be vegetated with the appropriate Zone 1 revegetation species down to the prism-out median water line. An approximate 25-foot wide area of the clean buffer area at the downstream end of removal Area 8B and the upstream end of Removal Area 9B was eroded. The area was inspected, photographed, and surveyed so that an approach for remedying the situation could be developed and proposed.

Potential erosion was also identified near the underground utility pipelines located near Removal Areas 10 and 11. Visible floodplain and bank soil was removed near and above the pipelines during excavation activities in that area. However, as described in Section 2.3.4, material located underwater was not excavated within 30 feet on either side of the pipelines or from in between the two pipelines. Due to the removal of the WCS and seasonal variations in water elevation in the water, the water level in the Kalamazoo River was significantly lower during the June 2009 inspection than it was at the conclusion of removal activities in January 2009. As such, more of the bank was exposed and appeared to be unstable. The area was inspected, photographed, and surveyed so that an approach for remedying the situation could be developed and proposed.

The proposed approach will be discussed with the appropriate oversight agencies. Adaptive management options could include the installation of coir logs to protect the banks and increase the vegetative density of the shoreline. Other measures, such as reseeding, installing plant plugs where seeding was ineffective, or increasing the amount of armor protection will be evaluated on a case-by-case basis and discussed with the appropriate oversight agencies prior to installation.

4.3 Vegetation Monitoring

Areas of restored vegetation will also be monitored for 3 years. Vegetation will be inspected twice annually during the monitoring period. Additional inspections may be performed during drought or flood conditions that could significantly affect planted vegetation. The monitoring inspections will be performed to evaluate the health and growth of planted vegetation and to determine whether stressful environmental conditions (e.g., insect infestations, deer browsing, and drought) are jeopardizing plant survival.

Implementation of an exotic/invasive species control program is an essential part of a successful revegetation program. Excessive weed presence will be discussed with regulatory agencies to determine if maintenance activities are required or if observed percentages reflect natural conditions in the region.

4.4 Post-Construction Monitoring and Maintenance Reports

Annual reports that document observations made during project area inspections (i.e., the stability of restored banks and the development of planted vegetation) will be prepared. The reports will summarize the progress of the restored vegetation toward reaching the performance standards, will describe maintenance activities that were required to adaptively manage the areas, and will provide photo documentation of restored banks and vegetation developed from established photo/observation vantage points.

4.5 Post-Construction Sediment Sampling

As discussed in Section 2.3.6 and in Section 5.6.1 of the Design Report (ARCADIS BBL 2007a), sediment sampling was performed at the end of each construction season to document PCB concentrations in the sediment removal areas. This is because confirmation in sediment removal areas consisted only of surface elevation monitoring, and did not produce any post-excavation PCB characterization sampling of sediments. Post-construction sampling provided useful data to document and monitor changes in PCB levels in the sediment removal areas.

Results of the 2007 post-construction sampling were transmitted to USEPA and MDEQ on March 3, 2008 in the letter titled *Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site Post-Removal Surface Sediment PCB Sampling Results for Removal Areas Completed in 2007* (ARCADIS 2008a). Results of the 2008 post-construction sampling were transmitted to USEPA and MDEQ on September 29, 2009 in the letter titled *Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site Post-Removal Surface Sediment PCB Sampling Results Former Plainwell Impoundment Time-Critical Removal Action* (ARCADIS 2009d).

4.6 Groundwater Investigation/Monitoring Program

An additional element of the post-removal site control is the implementation of a groundwater investigation/monitoring program, as described in Section 5.7 of the Design Report (ARCADIS BBL 2007a). The goals of the investigation are to evaluate the potential presence of PCBs within the groundwater, assess the migration of PCBs (if any) to the river, and to develop groundwater data that are of adequate quality to support an ecological risk assessment, if appropriate. The location and construction of the wells were discussed with and approved by USEPA and MDEQ. These discussions are summarized in the March 4, 2009 letter titled *Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site Time Critical Removal Action – Former Plainwell Impoundment Groundwater Monitoring Well Installation Plan* (Well Installation Plan, ARCADIS 2009a).

A network of 15 monitoring wells (MW-1 through MW-15) and five staff gauges were installed by Mateco Drilling Company between March 2 and March 27, 2009 under the supervision of ARCADIS. The locations for the 15 wells are shown on Figure 9. A reconnaissance soil boring was installed at each well location to refine the understanding of sub-surface stratigraphy. These borings were advanced to a minimum depth of 10 feet below the water table using continuous sampling techniques for soil classification purposes. The purpose of the reconnaissance borings was to verify that the assumed subsurface conditions (i.e., sands and gravels) are suitable for well installation. The data from the reconnaissance borings were used to confirm well locations and screening prior to setting outer casings.

Wells were constructed as described in Section 5.7 of the Design Report (ARCADIS BBL 2007a) and as modified in the Well Installation Plan (ARCADIS 2009a). All wells were installed using hollow-stem augers and were constructed with 2-inch Type 304 stainless steel risers.

Wells were double-cased with a 5-foot screen. Well construction logs are included in Appendix P.

Following installation, the wells were developed to remove fine-grained particles that remained in the wells and to re-establish the natural hydraulic flow conditions. A Watera mechanical pump and surge block apparatus was used to develop the wells during the week of March 30, 2009. Each 1-foot section of the well screen was developed for a minimum of 15 minutes. Purge water was collected in 55-gallon drums and was treated in a carbon adsorption tank similar to that used for treatment of construction dewatering decant and discharged to the ground.

In addition to the well network, five staff gauges were installed to monitor surface-water elevations within the Kalamazoo River. Staff gauges were mounted on fixed structures. The surface-water levels will be used in combination with groundwater levels to quantify groundwater discharge to the river and to track seasonal variability. The locations of the staff gauges are shown on Figure 9.

The horizontal and vertical coordinates of the monitoring wells and staff gauges, as well as the elevation of the top of each staff gauge and its zero point, were surveyed by a Michigan-registered surveyor and incorporated into the GIS database for the project. Horizontal measurements will be referenced to NAD 83, and vertical measurements will be referenced to NGVD 29.

Groundwater monitoring will be conducted for eight quarterly sampling events over a 2-year period. Prior to each sampling event, groundwater and surface water elevations will be monitored for a period of two weeks to verify that water is flowing to the river. During the sampling events, the monitoring wells will be sampled using ultra-low flow sampling techniques, and the readings on the staff gauges will be recorded. Surface water samples will be collected from the river within the former Plainwell Impoundment on the first day and last day of quarterly groundwater sampling activities and analyzed for the same laboratory parameters as the groundwater samples. Samples collected from the monitoring wells will be submitted to a laboratory for the following analyses (sample analytical methods to be consistent with the project-specific QAPP):

Table 14 -- Groundwater Investigation/Monitoring Analyses

Quantity[1]	Analysis
18 groundwater samples, 4 suface water samples	Total PCBs by Aroclor
18 groundwater samples, 4 suface water samples	Total Organic Carbon
18 groundwater samples, 4 suface water samples	Total Dissolved Solids
18 groundwater samples, 4 suface water samples	Total Suspended Solids
18 groundwater samples, 4 suface water samples	Chloride
18 groundwater samples, 4 suface water samples	Sulfate
18 groundwater samples, 4 suface water samples	Alkalinity
18 groundwater samples, 4 suface water samples	Sodium
18 groundwater samples, 4 suface water samples	Potassium
18 groundwater samples, 4 suface water samples	Magnesium
18 groundwater samples, 4 suface water samples	Calcium

[1]Consistent with the QAPP, one blind duplicate sample will be collected for every 10 samples of each sample matrix for all analytical parameters, and one matrix spike/matrix spike duplicate sample will be collected for every 20 samples analyzed for PCBs.

Results from the 2-year groundwater monitoring program will be evaluated after all data have been collected and analyzed. At that time, the monitoring team will estimate the rate of groundwater discharge from the former Plainwell Impoundment to the Kalamazoo River and the flux of PCBs (if any) from groundwater to the river. Analytical data will be submitted quarterly and an annual report will be submitted to document the results of the groundwater monitoring investigation.

5. Summary

This Completion Report documents the construction activities related to the former Plainwell Impoundment TCRA that took place between April 2007 and June 2009. The TCRA was performed in accordance with the Design Report specifications and Design Drawings. Exceptions or deviations from those documents were discussed with the regulatory agencies and are described in the appropriate sections of this Completion Report.

The objectives of the TCRA are listed below:

Material Removal (Objectives 1 through 4 from Section 1.3)

- Dredging and/or excavation of PCB-contaminated sediments upstream of the Plainwell Dam; in the three discrete sediment areas identified mid-channel; and within 40 feet from the existing bank.

- Cut-back and stabilization of river banks to mitigate exposures to PCB-contaminated banks and to control future erosion and achieve a stable channel.

- Removal of PCB-contaminated floodplain soils known from current data to contain PCB levels greater than 50 mg/kg PCBs.

- Removal of PCB-contaminated soil in excess of 4 mg/kg PCBs from the river’s northern floodplain on or near residential properties upstream of US 131, to the extent that the floodplain can be reasonably accessed.

Approximately 126,700 cy of soil and sediment was removed from the mid-channel, near-shore, bank, floodplain, upland, and island removal areas between June 2007 and January 2009. Where conditions permitted, bank soils were removed and/or unstable and over-steepened river banks were laid back at slopes no steeper than 3H:1V to reduce the potential for future and/or continued erosion and sloughing and to improve conditions for restored habitat features. A 30-foot wide clean buffer area was excavated back from the top-of-bank to remove PCB-containing soil. Removal of PCB-containing soil and sediment was confirmed using a combination of post-construction surface elevation and PCB concentration data.

Material Dewatering (Objective 5 from Section 1.3)

- Dewatering, as necessary, and disposal of all PCB-contaminated sediment, bank and floodplain soils removed to licensed offsite commercial landfills.

Sediment and soil dewatering was accomplished through the combination of gravity drainage, dry soil mixing, and the addition of solidification agents. Water collected from dewatering activities was treated in a multimedia filtration and carbon adsorption system. Stabilized material was transported to one of three licensed offsite commercial landfills.

Material Reuse (Objective 6 from Section 1.3)

- The use of clean soils excavated as part of the bank cutback work to cover floodplain soils contaminated above human health or ecological risk levels to the extent clean soils can be identified and isolated for use as cover.

Soil excavated as a part of bank cutback in Removal Areas 11A, 12A, and 13A were stockpiled for potential reuse as cover material. Each stockpile was sampled and the results were compared to applicable MDEQ Direct Contact Criterion RBSL. Based on these sampling results, no material was used as cover.

Resuspension Control (Objective 7 from Section 1.3)

- Control resuspended sediments.

Structures used to control resuspended sediment were installed prior to excavation of all removal areas. These structures were inspected daily and turbidity readings were collected throughout the project to monitor their effectiveness. Efforts to control resuspended sediment were generally effective at preventing elevated turbidity readings downstream of the work area. In the event elevated turbidity readings were observed (Mid-Channel Area B and Cofferdam Area 1), modifications were made to work activities to eliminate the elevated turbidity readings.

Plainwell Dam Activities (Objectives 8 through 10 from Section 1.3)

- An evaluation of the impact of removing PCB-contaminated sediments abutting the Plainwell Dam on the dam's structural integrity.

- An evaluation of whether a temporary or permanent lowering of the water level within the river may minimize movement of PCB-contaminated sediments during construction and/or the erosion of banks and floodplains covered with clean soils.

- Removal of one or more portions of the Plainwell Dam structure as needed to reduce the risk of sudden failure of the Plainwell Dam and/or minimize short- and long-term PCB mobilization from banks and floodplains.

Two cofferdams and a WCS were installed near the former Plainwell Dam to isolate sediments for removal, assist in removal of the former powerhouse structure, and control water levels in the river during the TCRA. The removal of the former powerhouse structure and the lowering of the water level within the river reestablished the western channel as the main channel of the Kalamazoo River. Prior to completion of the project, both cofferdams and the WCS were removed. The existing spillway in the eastern channel remained in place.

Post-Removal Revegetation and Habitat Reconstruction (Objectives 11 and 12 from Section 1.3)

- Establishment of a stable river channel post-removal action; revegetation with native plant species.

- Monitoring during and after the response action.

Monitoring and maintenance activities will be conducted to evaluate the stability of restored banks and the development of upland and wetland habitats towards meeting vegetation performance standards for 3 years.

This Completion Report provides a description of construction activities, material testing, and record drawings for all components of construction, which collectively serve to support the conclusion that the activities described in the Design Report have successfully been completed.

6. References

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Tables

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Appendices